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A

MANUAL OF PSYCHOLOGY.

VOLUME I.

BY

G. F. STOUT, M.A.,

LATE FELLOW OF ST. JOHN'S COLLEGE, CAMBRIDGE, AND UNIVERSITY LECTURER IN THE MORAL SCIENCES; EDITOR OF "MIND"; ANDERSON LECTURER ON COMPARATIVE PSYCHOLOGY IN THE UNIVERSITY OF ABERDEEN; AUTHOR OF "ANALYTIC PSYCHOLOGY," ETC.

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PREFACE.

The present work contains an exposition of Psychology from a genetic point of view. A glance at the table of contents will show that the order followed is that of the successive stages of mental development. The earlier stages have been copiously illustrated by reference to the mental life of animals. The phases through which the ideal construction of Self and the world has passed are illustrated by reference to the mental condition of the lower races of mankind.

The shortcoming which I have been most anxious to avoid is sketchiness. I am convinced that the study of Psychology is of no use to the student unless he is able to live himself into psychological problems, so as to acquire a real power of thinking for himself on psychological topics. For this purpose cut and dried statements skimming important questions are of no avail. An effective introduction to Psychology must be clothed in living flesh and blood, both for the student's own sake, and for the sake of his success in examinations. Nothing is more dreary and exasperating to the examiner than to read papers by a candidate who has evidently crammed books on Psychology, but who has never done a genuine bit of psychological thinking. The most essential gift to be imparted to the beginner is a real interest in the subject, and a real power of dealing with it even when familiar formulas fail him. He ought to be able to do riders in

Psychology as he does riders in Euclid. It is true that there are students who cannot advance so far from lack of natural endowment. But even for them a treatment full enough to be interesting and so remembrable is better than arid and dogmatic statements which have to be read over feverishly the day before an examination in order that they may not slip out of the mind. Certainly the teacher who needs Psychology for educational purposes would do much better to leave the subject alone altogether than to learn it in a merely external way.

My greatest debt here as elsewhere is to my teacher, Professor James Ward. In treating the special sensations I have found the fourth volume of Professor Foster's *Text-Book of Physiology* very useful. The special chapters on Light-Sensation and Sound-Sensation are abbreviated and adapted with modifications from Professor Ebbinghaus' *Grundzüge der Psychologie*. In general I have found much help in the writings of James, Baldwin, Ladd, Royce, and Lloyd Morgan. My proofs have been read by Mr. J. Welton, Lecturer in Education in the Yorkshire College, Victoria University, by Professor J. S. Mackenzie, of the University College of South Wales, and by Mr. M. C. W. Irvine, Mental and Moral Science Tutor in the University Correspondence College. I have found their services invaluable, and in particular I feel that the book owes much to the suggestions of Mr. Welton. My brother, Mr. J. F. Stout, has rendered me great assistance in preparing for the press, and has compiled the Index.

G. F. Stout.

Aberdeen, *November*, 1898.

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A MANUAL OF PSYCHOLOGY.

INTRODUCTION.

CHAPTER I.

THE SCOPE OF PSYCHOLOGY.

§ 1. *The Psychological Point of View.*—Let us suppose that a man is engaged in *examining* a material object. Let us say that he is *testing* the quality of a cigar. He *looks* at it; he *feels* it; he puts it to his ear and *listens* to the crackle which is a mark of dryness; he *smells* it before commencing to smoke; if he is not discouraged by these preliminaries, he may then proceed to smoke it; he thus brings into play the functions of *smelling* and *tasting*. Now in describing the man's procedure, we have had to use words such as *examining*, *testing*, *looking*, *feeling*, *listening*, *smelling*, and *tasting*. These are all terms standing for psychological facts.

So far as the man is pre-occupied with the object, he will not think of his own acts of looking, feeling, listening, etc. The qualities of the cigar itself are what he is aware of throughout the process. He is not aware of his own sensations, as such; sensations are qualifications

of his own consciousness, and not of the cigar; inasmuch as he is thinking of the cigar, he does not think about sensations.

On the other hand, the bystander who describes what the man is doing, naturally uses psychological terms. He is thinking, not only of the cigar, but the man in relation to it. What he has to describe is just this relation in its varying phases; he is not concerned with either the man or the cigar independently of each other. He thinks of the cigar merely as an object to which the man's activity is directed; and in consequence he thinks of the man as a subject which becomes aware of the qualities of this object, and adjusts his actions accordingly. But the man himself takes no note of the fact that the cigar is an object, and that he is a subject; he could not take note of the one fact without taking note of the other. But he is so wholly absorbed in the object, that he does not stop to consider its relation to himself as subject; in other words, though it is an object to him, he does not think of it as such. His point of view is essentially the same with that of the physical sciences. The point of view of the spectator is essentially that of psychology. Psychology is concerned with the relation of what is perceived, or in any way thought of, to the percipient or thinker.

It thus appears that psychology must take into account not only the subject but also the object. This is necessary because subjective states and processes cannot be adequately described without reference to their objects. It is impossible to name a thought without naming it as the thought of something or other. But psychology is only concerned with objects, if and so far as they are necessarily implied in the existence of corresponding states and processes in the subject. The object with which it has to

deal is always an object as perceived or thought about by some individual at some time. Of course, an object is always actually much more than this; the sensible qualities of the cigar belong to it both before and after the man has seen, smelt, touched, and tasted it. Not only is this true as a physical fact; but it is also recognised by the subject himself in perceiving or thinking about the object. The man only perceives the odour of the cigar in actually smelling it; but he regards it as a permanent quality, existing and persisting independently of his momentary perception. The question never occurs to him unless he begins to philosophise or psychologise. But if anybody should tell him that the odour, flavour, texture, dampness, or dryness of the cigar, only exist in the moment in which he thinks of them or perceives them, he would at once recognise, though perhaps dimly, that he had perceived them or thought of them as being something different from what they are now said to be. He had perceived them or thought of them as having a permanence and independence which is entirely irreconcilable with the supposition that they exist only if and so far as he is actually perceiving or thinking of them. But psychology is mainly concerned with the perceiving or thinking itself, and it therefore only takes account of the object so far as it is actually perceived or thought of. It is concerned, in the first instance, not with what is known, but with the process of knowing, not with what is willed, but with the process of willing, not with what is agreeable or disagreeable, but with the process of being pleased or displeased. Hence it takes no account of the object, except in so far as somebody is supposed to be actually knowing it or willing it, or being satisfied or dissatisfied with it. For the physical sciences the object is something that is to become

known; for psychology it is something which is actually in process of being known. *Psychology is the science of the processes whereby an individual becomes aware of a world of objects and adjusts his actions accordingly.*

§ 2. *Distinction from other Sciences.*—We have already marked off psychology from all physical sciences. The world of material facts and processes is the object of physical science; its whole aim is to know this object more completely and precisely. Psychology, on the contrary, does not directly and primarily aim at increasing our knowledge of the material world or any part of it. The cognitive process itself is an object of psychology. But psychology cannot itself take the place or fulfil the function of the cognitive process which it investigates. In turning its attention upon the function of knowing, it necessarily withdraws its attention from the special nature of the objects known. It must indeed constantly recognise the existence of these objects; but this is only because their existence is involved in the very conception of cognitive process.

This line of demarcation separates not only psychology, but also other departments of philosophy, from the physical sciences. We have now to distinguish the psychological point of view from that which characterises logic, theory of knowledge, ethics, and aesthetics. These are all concerned with knowledge, feeling, and will, rather than with their objects. But their attitude is different from that of psychology. Logic is a normative science; it is pre-occupied with the distinction between truth and error. It has to show how thought must proceed in order to represent its object correctly. Psychology, on the contrary, deals only with the laws that govern the cognitive process as it actually takes place. It is no

business of psychology to inquire how it ought to take place. The principles which it lays down account equally for correct thinking and for incorrect thinking. It deals with objects as they are actually presented to consciousness. It has no concern with the nature of the object as it may be apart from its actual presentation. It cannot, therefore, inquire whether or not the actual presentation corresponds to the true nature of the object as it exists in the real world.

Theory of knowledge pushes the question of truth and falsehood further back than logic. It inquires how truth and falsehood are possible at all; in other words, it investigates how the private thought of an individual can apprehend a reality independent of his own individual existence, either truly or falsely; how, for instance, can a finite consciousness, composed of a series of fleeting states, beginning to exist at a certain date and ending at a certain date, connected with and dependent on a body which forms only a small fragment of the infinite extension of the material world,—how can such a finite and particular being contain in itself the thought of the universe as a whole? How can it become a spectator of all time and all existence? Obviously, such questions are very far removed from the province of psychology. The possibility of thought is assumed by the psychologist. The relation of subject and object is pre-supposed by him as a datum. He simply investigates the actual laws which regulate the processes through which the subject passes in knowing, willing, feeling, in relation to the object.

Ontology may be regarded as an offshoot from theory of knowledge. Theory of knowlege inquires how the finite individual can be aware of the universe to which he belongs. It appears to some philosophers that this question cannot be

answered unless we give an account of the nature of the universe as well as of the individual. But an attempt to give an account of the nature of the universe, as such, is ontology. Evidently this is very far removed from psychology, which has only to do with the natural history of subjective processes as they occur in time.

What has been said of logic, theory of knowledge, and ontology applies also to ethics. Ethics inquires how we ought to will, not how we actually do will. It may push its investigation further, and inquire how the distinction between right willing and wrong willing is possible at all; and finally, it may attempt to answer this question by giving an account of the nature of the universe as a whole. Psychology, on the other hand, deals only with the process of volition as it actually occurs, without reference to its rightness or wrongness, or to the ultimate conditions which make rightness and wrongness possible.

Aesthetics is precisely analogous to ethics, except that the distinction between beauty and ugliness is substituted for that between right and wrong. Psychology has nothing to do with this distinction, as such. It only inquires how things actually come to appear beautiful or ugly; it has no concern with such questions as whether what appears beautiful really is beautiful, or how the distinction between beauty and ugliness is constituted. Perhaps what appears beautiful therefore is beautiful; if this be so, then psychology solves the problems of aesthetics; but it does so only by accident. It cannot itself show that it has solved these problems. In order to do so, it would have to prove that in aesthetics appearance and reality coincide; but whether this be true or false, it is certainly beyond the province of psychology to discuss the question.

§ 3. *Consciousness.*—If we analyse such processes as those of looking, listening, smelling, or tasting, we find that they involve two distinct and disparate groups of facts. On the one hand, they are modes of consciousness, specific kinds of experience; on the other, they imply occurrences taking place in the bodily organs of sense which do not, as such, enter into the conscious experience of the subject. For instance, a man in looking at an object moves his eyeballs; this involves the existence and operation of a muscular apparatus; but the operation of this muscular apparatus is not, as such, a constituent of his conscious state. It exists for the consciousness of the psychologist or physiologist, who is analysing the visual process; but it does not form part of the act of looking at an object so far as this is an experience of the subject who sees the object. The subjective experience is conditioned by, but it does not contain the muscular process. We may express this by saying that though the muscular process is a psychological fact, in the sense that it is a fact that psychology must take account of, yet it is not a psychical fact, viz., a fact of consciousness. The term *psychological* is wider than *psychical*: all psychical facts are psychological facts, but not all psychological facts are psychical facts. A psychical fact must be in some way or other an experience of the subject whose processes the psychologist is investigating.

A psychical fact is a fact of consciousness; but what is consciousness? Properly speaking, definition is impossible. Everybody knows what consciousness is because everybody is conscious. It is not, however, enough simply to say this. Confusion would be sure to arise if we passed the question by in this manner. The difficulty is that consciousness has manifold modes and degrees; and there is

always a danger of restricting the term so as to make it apply to certain modes and degrees and not to others. Historically, the word has been used by certain writers for the awareness which we have of ourselves and of our own experiences, as states of the self. Indeed, consciousness has been called an inner sense, and has been regarded as a special function by which we perceive the mind and its processes; just as sight and hearing are outer senses for the perception of material facts. In opposition to all such views, we must state definitely that consciousness includes not only awareness of our own states, but these states themselves, whether we have cognisance of them or not. If a man is angry, that is a state of consciousness, even though he does not know that he is angry. If he does know that he is angry, that is another modification of consciousness, and not the same.

Wherever there is not total unconsciousness in the sense in which we attribute unconsciousness to a table or a log of wood, consciousness in some mode or degree is present. As Professor Baldwin says, it is "the common and necessary form of all mental states; . . . it is the point of division between mind and not-mind."* To quote Professor Ladd: "What we are when we are awake, as contrasted with what we are when we sink into a profound and perfectly dreamless sleep, . . . *that* it is to be conscious. What we are less and less, as we sink gradually down into dreamless sleep, or as we swoon slowly away: and what we are more and more, as the noise of the crowd outside tardily arouses us from our after-dinner nap, or as we come out of the midnight darkness of the typhoid-fever crisis—"† *that* is consciousness. The becoming conscious

* *Elements of Psychology*, p. 57.

† *Psychology, Descriptive and Explanatory*, p. 30

and the becoming unconscious are in all their phases and gradations states of consciousness. They are not states of unconsciousness, nor are they transition states between consciousness and unconsciousness. There are no such transition states. The very dimmest and vaguest feeling accompanying the last stage of sinking into dreamless sleep, or the first stage of gradual awakening, is already consciousness. It may become fuller consciousness, but it cannot become consciousness, for it is that to begin with. If, as some suppose, the dreamless sleep itself is accompanied by some dim feeling, this dim feeling is dim consciousness.

It should be noted that though there are psychological facts which are not psychical, their psychological character is derivative and subsidiary. The psychologist takes account of them only if, and so far as, they are necessary in the formulation and explanation of processes which are in the proper sense psychical, which in some way enter into consciousness.

CHAPTER II.

THE DATA AND METHODS OF PSYCHOLOGY.

§ 1. *Presented Objects as Data.*—Psychology has to discuss mental processes, such as sensation, perception, attention, volition, and the like. But except in the case of pure sensation,* none of these processes can either exist or be conceived apart from a presented object. We cannot attend, perceive, or will, without perceiving, willing, or attending to something. Now, the object which is presented to any individual subject at any moment exists for it at that moment only in virtue of subjective processes which are then occurring, or which have occurred previously. The development of an individual mind is at the same time the development of the objective world as presented to that individual mind. The limits of its possible development are also the limits of the real world as a possible presentation to its consciousness. It follows from this that presented objects are most essential and important data for psychology. Being the effects of psychological causes, they form an indispensable starting-point in investigating the nature of these causes. In this respect psychology presents an analogy to other sciences of development, such as geology and biology. Geology finds an actual formation of the earth's crust: it finds a certain arrangement of strata, and it inquires by what processes this arrangement has arisen.

* This exception will be explained in Book ii., Ch. 1.

Similarly, psychology finds a certain world of objects presented, let us say, to an educated Englishman of the nineteenth century, and it inquires how this world has come to be presented. The geologist finds different strata arranged according to the successive periods of their formation. Similarly, the psychologist finds different psychological strata. The world of the young child, or the world of the Australian aborigine, are comparatively primitive formations; and the psychological problem is to discover how the transition has been made from these earlier stages to the later stages with which civilised adults are now familiar. Sometimes the arrangement of geological strata is disturbed by volcanic conditions; similar upheavals also take place in the case of mind, in the various forms of insanity.

Let us take a single example of a presented object as a psychological datum. A man looks into a stereoscope, and he is asked what he sees. He replies that he sees a cathedral, looking solid in the same manner as an actual cathedral would look solid. He may go on to describe the object in detail, and he need not at any point in his description use psychological terms. He will speak, not of perceptions, feelings, and sensations, but of the spire, the roof, the windows, etc. Now spire, roof, and windows, whether of an actual church, or of one seen through a stereoscope, are not subjective processes; nevertheless, solid figure as seen through a stereoscope is a most important datum for the psychological theory of the processes by which we perceive the third dimension of space. The appearance of solidity is produced, not by a solid thing, but by two flat surfaces on which are drawn representations of the cathedral or other object as seen from different points of view; we know therefore that the perception

of a solid object depends on processes which do not involve as their necessary condition the operation on the organ of vision of that solid object itself. We find by a process of exclusion that the only essential conditions which can be operative in producing the distinctive stereoscopic effect are certain peculiar experiences connected with the use of the two eyes. These experiences are not of course part of the object; they only become known through the psychological inquiry which attempts to account for the presentation of the object. The special importance of this case arises from the presentation of the object taking place under experimental conditions which can be precisely analysed.

But the general method is by no means confined to experimental cases. "Since the whole world, as it exists for an individual consciousness, whether from a practical, theoretical, or aesthetic point of view, has come so to exist through prior mental process, it may be said that there is no objective fact which is not capable of being utilised by the psychologist. From this point of view we may say, with Dr. Ward, that 'the whole choir of heaven and furniture of earth,' so far as they are known, are data for psychology. (Article 'Psychology,' *Encyclopaedia Britannica*, 9th ed., vol. xx., p. 38). So too, are all works of imagination, *e.g.*, the *Iliad* or *Hamlet* or Grimm's *Fairy Tales*, and all rules of conduct, *e.g.*, Roman law, the Brahman ritual, the four books of Confucius and Mencius. We must, however, carefully note that mere examination of mental products is valueless for psychology, except in so far as it helps us to trace mental process. This purpose is best served when we can arrange the products as parts of a historical series, in which each may be treated as the goal of preceding, and the starting-point of succeeding,

development. Thus we may profitably compare the views of the world as it presented itself to Homer, to Socrates, and to Darwin respectively. Hence the great importance of philology and anthropology to the science of mind. The products of thought are embodied in language, so that the comparison of the vocabulary and of the syntactic structure of different languages is a means of comparing different stages of mental evolution. The comparative study of the religious and other beliefs of primitive races has the same kind of psychological value, and the same holds good as regards their technical and artistic productions. Again, apart from any reference to historical order, we may compare the same object as it is presented to different minds, or to the same mind under different conditions. This course yields important results, when we can assign definite circumstances on which the variation depends. Thus, by comparing space as it exists for persons possessed both of sight and touch, with space as it exists for the blind, we may obtain valuable data for determining the part played by visual experience in the development of this perception. A flood of light is thrown on the conditions of mental development in general by examination of the cases of such abnormal individuals as Laura Bridgman or Helen Keller.* Under the same head come the data supplied by mental pathology, including cases of aphasia, psychic blindness, and so forth."†

It should be borne in mind that a presented object as a datum of psychology need have no actual existence in the

* Laura Bridgman and Helen Keller were deprived almost from birth of the senses of sight and hearing: and yet both reached a high degree of mental development. For Laura Bridgman see Stanley Hall's article in *Mind*, O.S. iv., p. 149. For Helen Keller see *Mind*. O.S. xiii., p. 344, xiv., p. 305, and N.S. i., p. 574, ii., p. 280.

† *Analytic Psychology*, vol. i, pp. 9-11.

real world. The solid figure seen in the stereoscope is not actually present; but it is none the less perceived, and that is all with which psychology has any concern. Its real presence or absence is a matter of physical fact, not of psychical fact. Its absence is important for psychology only because it involves the absence of certain conditions which might otherwise be supposed to be essential to the presentation of solidity.

§ 2. *Introspection.*—To introspect is to attend to the workings of one's own mind. When instead of asking what we perceive or will, we inquire how we perceive or will, or how we come to perceive or will, the answer, so far as it can be obtained by direct observation, depends on introspection. Thus, to take once more the case of the stereoscope. Because the solid object is not physically present, someone may say that its presence is merely inferred. From a purely logical point of view, this may be true. If a man, deceived by the stereoscopic appearance, were called upon to define his reasons for believing the solid object to be physically present, he would no doubt say that it looks solid, just as if it were really so. He would then be assigning a peculiar visible appearance as a reason for assuming a physical fact. But if it is meant that the actual visible presentation of solidity is itself an inference, appeal must be made to introspection. Inferring is a mental process with which we are familiar. In it we proceed to a conclusion, which is mentally distinguished or distinguishable from its premises. But in the stereoscopic illusion there is no distinguishing between premises and conclusion, or transition between them. On the evidence of introspection, therefore, we say that inference as a psychological process is not present. Take another example. A man shows us a pretty chess

problem and its solution. Neither his mental attitude nor ours is introspective while he is telling us about the problem. But suppose that he goes on to describe how he came to invent the problem, or how he came to discover its solution; he will then be describing the workings of his own mind. He will speak of his disappointment and perplexity, his renewed hopes, his despair when all possible ways appeared futile. He will perhaps tell us how the understanding of the whole problem flashed upon him suddenly with the key-move, every element in it then assuming its right place, so that his subsequent mental activity became smooth and easy. All this is introspection. Consider next an example from the sphere of practice. A general gives an important order, or a responsible statesman puts before the world a scheme of policy. Neither the general's order nor the statesman's scheme directly expresses psychical facts; but if the general begins to tell us how he was led to give the order, he will, in all probability, describe the process of his own consciousness. He may tell us that his mind for a time oscillated between alternative lines of conduct; now one appearing better, and now the other. He may tell us that the state of indecision, where there was need for prompt action, became unbearable; and that he suddenly put an end to it by fixing on one definite decision, without any real conviction that it was the best. Or again, he may describe how the decision emerged gradually out of his previous hesitation, so that he awoke one morning with a clear conviction that a certain course was the right one.

Much has been written about the difficulty and untrustworthiness of introspection. It is often urged that psychology, in so far as it rests on an introspective basis, must always be in an unsatisfactory condition. But it

must be remembered that quite apart from any aid which he may receive from physiology, the psychologist has at his command a vast mass of data which are not due to introspection. This we have brought out in the preceding section on presented objects as data for psychology. It is conceivable that this class of data alone would serve as the basis of hypotheses explanatory of the development of mind. Thus we might have a kind of psychology without introspection, and yet quite distinct from physiology. What introspection does is to supply us with a direct instead of a hypothetical knowledge of mental process. It thus forms a source of psychological material which is invaluable and unattainable by any other means. But the ultimate test of psychological theories is their power to explain how the world comes to exist for the individual mind. The ultimate data of the science are therefore objects as presented to the individual mind, in successive phases, and under varying conditions of its development.

Turning now to the alleged obscurities, fallacies, and difficulties of introspection, we may note at the outset that these do not exist when the questions which it has to answer are made sufficiently broad and simple. There is no fallacy, obscurity, or ambiguity in the statement that when I have toothache I dislike it very much, or that I was afraid when I saw a white figure in a churchyard. There is no fallacy or ambiguity in the statement that feeling pleased is different from feeling displeased, or that when we are fully convinced that an action is totally impossible, we cannot voluntarily determine to perform it. Facts of this kind can be observed with ease and certainty by everyone. Now if introspection could only supply us with such simple and obvious data, it would none the less be of essential value. It would supply us with the general

terms in which to describe mental process. The more precise determination of such process in detail might be hypothetical, and dependent on other data as the ultimate test of its correctness. To a large extent this is the case. In this respect psychology is on a footing with other sciences. If we ask for the actual observations of the process of natural selection on which the Darwinian theory is based, we find what appear very slender foundations of fact for a very large superstructure. There are the experiences of the breeder, and very little more. The real data which support the weight of the theory consist in the nature of the actual products which the process is assumed to explain,—the actual constitution of animal and vegetable species in their higher and lower forms.

The deliverances of introspection are not, however, limited to such simple and obvious issues as we have mentioned. Like all other modes of observation, it is capable of being immensely improved by systematic training and practice. The plain man, as Dr. Sidgwick calls him, has, as a rule, no permanent and absorbing interest in the workings of his own mind. His attention is mainly engrossed by other objects. Thus, the introspective attitude is unfamiliar to him. This unfamiliarity is the chief reason why he seems so helpless when called on to observe the finer details of his own mental operations. Like a person passing from full illumination into a dimly-lighted room, he can at first discern little; but in time his power of discrimination may increase. By repeating his observations again and again, and comparing them with each other, he makes gradual progress. The result of previous observation becomes the basis of a new advance. This is of course in no way peculiar to introspection. A man who is only beginning to observe in a systematic way fine distinctions

between tastes, smells, and colours, shows at first the same helplessness. Advance is made as the cumulative result of a series of successive efforts of attention, each paving the way for the next. It is indeed a commonplace that the practised observer notices at once what the untrained fail to see even when it is pointed out. But besides individual practice there is yet another element in the training of the introspective psychologist. He derives immense help from the work of his predecessors. They teach him what to look for, and how and where to look for it. Thus what the introspection of one generation has achieved becomes the starting-point for fresh progress in the introspection of the next. The advance that has actually been made in this way is immense, as at once appears on comparing from this point of view the work, let us say, of Aristotle, with that of William James.

Nevertheless, it must be admitted that there are certain drawbacks attaching to the introspective process which cannot wholly be overcome even by sustained practice and systematic training. The most important drawback is that the mind in watching its own workings must necessarily have its attention divided between two objects,—on the one hand, the mental operation itself which is to be observed, and on the other, the object to which this mental operation is directed. If I observe the process of seeing, I must attend at once to what is seen, and to the seeing of it. If I observe what takes place in attending, I must first attend to something, and then to the process of attention. Thus if the introspective effort is sustained and strenuous, it is apt to destroy the very object which it is examining. For by concentrating attention on the mental process, we withdraw it from the object of that process, and so arrest the process itself. Thus, introspection, when it is directly

concerned with a mental operation that is in itself more or less absorbing, can only proceed by taking a series of transient side-glimpses. This difficulty is, however, not so serious as it appears; for, in the first place, retrospection is to a large extent free from it. By calling up a process in memory immediately after it is over we are often able to notice much that escaped us when it was actually going on. In like manner the astronomer can call up in memory the image of a star which has just passed before his vision; and can then notice details which had escaped him at the moment of its actual appearance. In the next place, we must bear in mind that it is not the isolated observation which is of importance in introspective psychology, but rather the accumulation of a vast number of observations, each helping the others. Thus, what is important is to acquire a general habit of alertness, a perpetual readiness to attend to the workings of our own minds whenever opportunity presents itself; and it must be noted that opportunities are constantly presenting themselves; the subject-matter which we have to observe is perpetually with us. This may be set down as a grand advantage of introspection, compensating in a high degree for its drawbacks. Finally, introspection, to be effective for the advancement of science, must, like other modes of observation, be carried on by a number of experts in co-operation. Each must communicate to the rest his own results, for confirmation or rejection. Thus, it is an essential part of his business to state his results in such a form that they can be tested by others. He must be able to point out to others exactly where and how to look for what he himself has observed. This is most easy when the method of experiment, as distinguished from mere observation, is followed, and constitutes one of

the main advantages of that method. Of course, what is true of one individual, A, may not hold good of another, B; but B's inability to confirm A by his own experience should deter A from setting down as true for all men, or most men, what holds good only for some persons, possibly only for himself.

§ 3. *Manifestations of Mental Process in Others.*—No one can directly observe what is passing in the mind of another. He can only interpret external signs on the analogy of his own experience. These external signs always consist in some kind of bodily action or attitude. Thus when a man clenches his fist, stamps, etc., we infer that he is angry. When a dog wags its tail, we infer that it is pleased. The knowledge acquired in this way must be carefully distinguished from that which is obtained through intercommunication by means of language. When a man tells us that he is or was angry, he is not directly expressing his anger, but his knowledge of his anger. He is conveying to us the result of his own introspection. This source of information is in no way peculiar to psychology. It does not differ from any other communication of observed facts by means of words. The peculiarly psychological inference rests on signs which may or may not be noticed or understood by the subject who displays them. On the other hand, communication by means of language necessarily pre-supposes that the person communicating the information is himself aware of the meaning of the words which he uses. He must first understand himself in order to make others understand him. It may happen that the inference from the direct expression of the mental state may contradict the subject's own assertion about it. He may show most unambiguous symptoms of anger, and at the same time declare vehemently that he is not angry.

In the case of the lower animals and young children, it is impossible, and in the case of savages it is difficult, to obtain verbal descriptions of their own mental states and processes. This is partly because they either do not use language, or use a language inadequate for the purpose, and partly because they are not introspective. Under such conditions our only course is to rely on the interpretation of the appropriate external manifestations of the processes themselves. Interpretation becomes more difficult in proportion to the difference between the mind of the psychologist and the mind which he is investigating. The interpretation must rest on some analogy between the two. But if the analogy is only partial and accompanied by great diversity, a constructive process is necessary. It is in his own mind alone that the psychologist has the constituent elements from which an interpretation can be framed. "All depends on accurate resolution of his own complex consciousness into its constituents, and on re-compounding these in such a way and in such proportions as to explain the nature and order of the signs which indicate to him the mental processes of others."* For instance, he finds among savages a wide-spread belief in the power of all kinds of odds and ends to influence the fortunes of the person possessing them. This is a prevailing tendency of savage thought; if the psychologist looks for analogies in his own mental life, he will find them few and far between. But they are not likely to be wholly absent. There are moments in which he either has been influenced or has felt strongly inclined to be influenced, by considerations in themselves as meaningless as those on which the savage relies. The fall of a picture, or the spilling of salt, or the presence of thirteen at table, may make him uneasy in spite of

* *Analytic Psychology*, vol. i., p. 15.

reason. If he has ever been carried away by the gambling impulse, he must have been almost irresistibly prompted to regard quite irrelevant details as having an essential bearing on his winning or losing. In order to construct the mental state of a savage, he must carefully observe and analyse these transient and occasional mental attitudes in which he approximates to savagery. He must then attempt to represent a mind in which tendencies, that, in him, are so overborne by other conditions as to be transient and occasional, are unchecked by opposing forces, and for that reason prominent and permanent. It sometimes happens that a man is so destitute of a certain kind of mental tendency himself, that he is unable to understand its presence in others. Thus, Charles Lamb tells us that his friend, George Dyer, could never be brought to say anything in condemnation of the most atrocious crimes, except that the criminal must have been very eccentric.

The besetting snare of the psychologist is the tendency to assume that an act or attitude which in himself would be the natural manifestation of a certain mental process must, therefore, have the same meaning in the case of another. The fallacy lies in taking this or that isolated action apart from the totality of the conditions under which it appears. It is particularly seductive when the animal mind is the object of inquiry. The economy of a beehive displays such adaptation of means to ends, as to suggest strongly far-reaching prevision and political faculty of a human kind in the bees. But it would be very rash to trust this first impression. We must first consider all the other actions of bees and similar insects; we must also examine in detail how the individuals concerned severally perform the separate acts which in their combination constitute the orderly scheme of organization of bee society.

We shall then find that the most essential modes of behaviour, especially on the part of the queen-bee, are due to congenital tendencies, which operate independently of previous experience. We must further take into account the physical organisation of the bees. Their nervous system differs so widely and in such a manner from the human, as to make us hesitate before ascribing to them so very large a share of processes especially characteristic of human beings. Finally, we find that the division of labour which makes the bee community possible, is directly determined by congenital differences of physical organisation. The queen-bee, the worker, and the drone, differ not only in their actual behaviour, but in their bodily constitution. The bodily constitution is so prearranged by nature as to be adapted for certain special functions. Here all analogy with the political organisation of human beings breaks down. This is a typical instance. The lesson to be learnt from it is that in investigating the mental conditions of persons or animals widely removed in their general circumstances and conditions from our own, we must assume an attitude of critical suspense until we have taken into account everything which can have a bearing on the problem.

This warning is the more important because human language is especially constructed to describe the mental states of human beings, and this means that it is especially constructed so as to mislead us when we attempt to describe the workings of minds that differ in any great degree from the human. The very implications of the words we are almost compelled to use in describing what we suppose to go on in the mind of a dog or a cat surreptitiously introduce interpretations which may be quite false, and often are so. It is, therefore, above all things necessary

in these cases to criticise our language, avoiding popular phraseology, and substituting technical terms with fixed meanings carefully defined. A horse, having had a feed at a certain place on one day, stops of his own accord at that place on the second journey. People say that it remembers being fed there before, and infers that it will be fed there again. In all probability these words with their human implications are quite misleading. Suppose that the driver of the horse is a bibulous person, who takes a drink as a matter of course whenever he comes to a public-house on the road. In order to do this he need not go through the process of remembering that he has had a drink at a public-house before, or of inferring that he can have a drink at a public-house again. He simply has a bias to stop at a public-house whenever he comes to one. Probably the horse's act implies just as little of remembering or inferring.

§ 4. *Experiment and Observation.*—To experiment is to observe under conditions which we have ourselves pre-arranged. The pre-arrangement is intended to simplify the issue that is to be decided, by excluding irrelevant conditions. In this wide sense psychology has always been to some extent experimental. What is especially modern is the introduction of apparatus and of exact measurement, such as are employed by the physical sciences. Experiment may be used in connexion with any of the modes of observation which we have described. It generally involves more than one of them, and often all three. The primary question may be, what kind of object will be presented under certain assignable conditions. A simple illustration is afforded by the old Aristotelian experiment of holding an object between the second finger and the forefinger of the hand, not in their usual position, but with

the second finger crossing backwards over the forefinger. Under these circumstances, there arises a perception of doubleness, so that we appear to be touching two distinct objects instead of one. Here the question is, what object do we perceive under the given conditions? Is it single or double? We may also put a question to introspection proper, and ask how far our mental attitude resembles that which exists in ordinary cases in which two objects are perceived by touch, *e.g.*, when two opposite sides of the same finger are touched. In my own case, for instance, I find that when two opposite sides of the same finger are touched, the appearance of doubleness is more definite and unmistakable. With the crossed fingers there is a certain sense of strangeness and hesitancy which is absent in the ordinary perception of doubleness. Another case in which the primary question relates to the presented object is that of our stock example—the stereoscope. Here the conditions of perception are pre-arranged by means of a special apparatus, and the question is, what, under these conditions, is the nature of the object apprehended? Here, too, the introspective inquiry may be also raised, if we ask whether our apprehension of the object is direct or due to a process of inference. It is also possible to make experiments in which the primary issue is introspective. Thus, we may attempt to will something which we know to be impossible, in order to find out whether we *can* do so or not. Or again, we may deliberately attempt to attend simultaneously to two disconnected objects, with the view of discovering whether attention can be so divided.

Finally, we may experiment on the connexion between a mental state and its external manifestation. In this way, it is possible to discover many subtle signs and symptoms of mental process which evade ordinary observation.

For instance, variations in the circulation of the blood, and in respiration, and in muscular power, accompanying various phases of emotion, may be accurately measured by physical apparatus. In principle, this kind of experiment often occurs in ordinary life. Whenever we say a thing or do a thing to a person, in order to see how he will take it, we are performing a psychological experiment.

It is clear that the experimental method does not disclose any essentially new source of psychological data. It is only observation under test conditions, deliberately prearranged for the purpose of settling a definite question. It is not quite accurate to define it merely as observation under test conditions. For test conditions may arise in the ordinary course of things, without any deliberate prearrangement on our part. All pathological cases come under this head. In such cases as those of Laura Bridgman or Helen Keller we have an opportunity of observing, under test conditions, what the sense of touch alone can effect, in the absence of sight, hearing, smell, and taste. But the test conditions are such as could not be pre-arranged by the psychologist. He is not permitted to make people blind and deaf from their birth in order to watch the consequences.

The experimental method has often great advantages; but it has also certain drawbacks. The very conditions which we wish to investigate are often such as occur only in the normal course of mental life, and are interfered with by artificial arrangements. For instance, experiments on the association of ideas labour under this defect. The question which interests us is how the succession of ideas is determined in ordinary thinking. But experiment subjects the mind to conditions which are quite remote

from those of the normal flow of thought. In experiment, isolated words or other objects are successively presented to a person, and he is called on to name the first idea which each of them suggests to him. Thus, continuity of interest, which is all-important in ordinary thinking, is excluded. Another question in which the experimental method is seriously defective is that relating to the mental imagery accompanying the use of words. When we deliberately select a word, and ask ourselves what imagery it calls up in our minds, we are by the very process of our inquiry interfering with the result. We are looking for mental imagery, and we have no right to affirm that the imagery which we find would be present if we had not been looking for it. The only safe course in such a case as this is to cultivate the habit of watchfulness, so that we may frequently catch ourselves in the act of using words in a natural manner in the ordinary course of thought. This perpetual readiness to notice what is taking place in our own minds, without deliberately resolving to do so, on this or that special occasion, is at once a most difficult and a most necessary equipment of the introspective psychologist.

The special function of the experimental method has been well stated by one of its most enthusiastic advocates, Professor Titchener. "An experiment is a trial, test, or observation, carefully made under certain special conditions: the object of the conditions being (1) to render it possible for any one who will to *repeat* the test, in the exact manner in which it was first performed, and (2) to help the observer to rule out disturbing influences during his observation, and so to get at the desired result in a *pure* form. If we say precisely how we have worked, other investigators can go through the same processes, and judge whether our conclusions are right or wrong; and if

we do the work in a fitting place, with fitting instruments, without hurry or interruption, guarding against any influence which is foreign to the matter in hand, and which might conceivably alter our observation, we may be sure of obtaining 'pure' results, results which follow directly from the conditions laid down by us, and are not due to the operation of any unforeseen or unregulated causes. Experiment thus secures accuracy of observation, and the connection of every result with its own conditions; while it enables observers in all parts of the world to work together upon one and the same psychological problem."*

§ 5. *Quantitative Methods.*—A science becomes more exact in proportion as it deals with exactly measured quantities. Of late years, a strenuous effort has been made to measure the duration and intensity of psychical process. What are called reaction-time experiments are intended to measure the duration of simple mental operations. "It is agreed between two persons, the 'experimenter' and the 'reactor,' that on the occurrence of a certain sensory stimulus† (given by the experimenter) a certain movement shall be made (by the reactor)."‡ The time elapsing between the occurrence of the sensory stimulus and the execution of the movement in response to it is accurately measured. The responsive movement may follow at once upon the becoming aware of the effect of the stimulus, or "be restrained until certain connections have been formed in consciousness. In the former case, we speak of a *simple*, in the latter, of a *compound*, reaction."§ The simple reaction has two forms, the muscular and the sensory. "In the muscular, ... the reactor is

* *An Outline of Psychology*, p. 35.

† Such as the sound of a falling body. A sensory stimulus is a stimulus acting on an organ of sense such as the eye or the ear.

‡ *Op. cit.*, p. 319. § *Ibid*, p. 320.

directed to hold his attention from the outset upon the movement which is to be made in response to the stimulus."* In the sensory, "the reactor is directed to hold his attention from the outset upon the sensory stimulus, and to withhold the reaction movement until he has sensed that stimulus."† One result of these experiments is that the muscular reaction occurs in a distinctly shorter time than the sensory. When the attention of the reactor is fixed in preparation for a coming sensation, he waits until he is distinctly aware of the presence of the sensation before reacting. On the other hand, in the muscular reaction, the reactor, being pre-occupied with making ready for his own reaction, need not wait till he is fully aware of the presence of the sensation. Hence he becomes with practice able to react before he has any distinct consciousness of it. The stimulus, as soon as it begins to operate, produces simultaneously sensation and reaction. The time taken by the simple reaction varies according to the nature of the stimulus. The sensorial reaction to light lasts about 270-thousandths of a second. A thousandth of a second is symbolised by the Greek letter σ. The muscular reaction to light lasts 180σ. The sensorial reaction to sound lasts 225σ, and the muscular 120σ. The sensorial reaction to pressure lasts 210σ and the muscular 110σ.

Accuracy of measurement is secured by special apparatus. An electric clock or chronoscope, as it is called, marks thousandths of a second. The production of the stimulus sets this clock going. The finger of the reactor all the time rests lightly on the button. The movement he makes by way of reaction consists in a slight pressure on this button, which immediately stops the clock.

* *Op. cit.*, p. 325. † *Ibid.*, p. 323.

In the compound reaction, various complications are introduced. The reactor may be called on to discriminate between two sensations, reacting only to one of them. Thus he may be told "that he will be shown either black or white, and that he is to react when he has cognised the black as black or the white as white; but he does not know which of the two brightness qualities to expect in each particular experiment."* In this case, he knows that either white or black is to be looked for. The conditions may be further varied, so that he has no definite knowledge of the alternatives which are to be submitted to him, although he is expected to react on one of them, and one only. "Thus he may be told that he will be shown a light stimulus, and that he is to react when he has cognised this stimulus as a particular brightness or a particular colour; but nothing more explicit is said."†

The measurement of the *intensity* of psychical states is attended by peculiar difficulties, due to the intrinsic nature of the quantity to be measured. The degree of loudness of a sound cannot be broken up into fractional parts which can be marked off from each other. We cannot say by direct comparison of two sounds that one is half, or a quarter, or a third, or twice as loud as the other. The two sounds cannot be superposed so as to make the fainter coincide with part of the louder, leaving a remainder which can be regarded as the quantitative difference between them. In this respect intensive differs from extensive quantity. The difference between two extensive quantities is itself an extensive quantity. The difference between two lines, one a foot long and the other ten inches long, is itself a line two inches long. But the difference between the loudness of two sounds is not itself

* *Op. cit.*, p. 328. † *Ibid.*, p. 329.

a sound having a certain assignable loudness. "The difference between two intensive quantities, in fact, differs from each as much as the difference between two horses differs from a horse."*

Nevertheless, the attempt to measure intensive magnitude is not so desperate as it appears. Clearly we cannot take one intensive quantity as the unit of measurement of others; but we may take as unit of measurement the difference or interval between *two* intensities. Suppose that we are considering, instead of two sounds, two pairs of sounds. Symbolise the one pair by A and B, the other by α and β. We find that we are able to judge whether the difference in loudness between A and B is or is not equal to the difference in loudness between α and β. Thus, if we have a scale of increasing gradations of intensity, we may take as our point of departure any given intensity in the scale. We can then arrange other intensities in relation to this, proceeding by intervals which we judge to be equal. By counting these equal intervals we can assign a numerical value to any intensity in the scale. The unit which is of most use is the least perceptible difference, viz. that difference between two intensities which makes it just possible for us to be aware that there is a difference at all. All least perceptible differences in the same class of intensities are regarded as equal to each other, because they appear equal when compared.

Instead of measuring psychical process, we may measure its external manifestations or conditions, and we may also measure the objects which are presented by means of it. As an example of the first kind of procedure, we may refer to the measurement of variations in the circulation of the

* B. Russell: "On the Relations of Number and Quantity," *Mind*, N.S. vi., p. 334.

blood, and in the action of the lungs, under varying phases of emotion and pleasant or painful feeling. The measurement of the presented object is of value when it can be brought into definite relation with varying conditions of presentation. The best example is supplied by recent attempts to measure certain geometrical illusions of visual perception. The following is a good illustration. Two lines in reality parallel are each intersected by slanting cross-lines, the cross-lines of the one being opposed in direction to the cross-lines of the other. The parallel lines are then not perceived as parallel, but as diverging in the direction in which the cross-lines would meet if produced, and converging in the opposite direction.

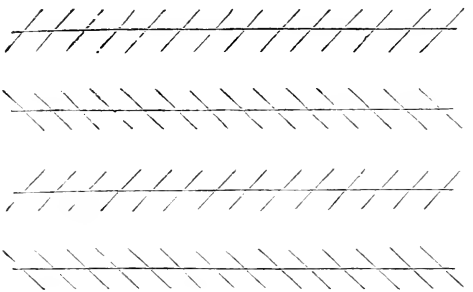

Fig. 1.

Now, to measure the amount of illusion, we have only to substitute for parallel lines lines really convergent in such a manner and degree that they appear parallel under the same conditions. The degree of convergence required for this purpose measures the amount of the illusion. By this means it is possible to trace the variations which take place in the amount of the illusion

with variations in the conditions. It is found to vary according to the number and obliquity of the cross-lines. It exists in a fainter degree when the cross-lines merely meet the parallels without intersecting, or when they approach them without meeting. By establishing definite quantitative values for these varying cases valuable data are supplied for discovering the process on which the illusion depends. Actual experiments of this kind of course require a specially contrived apparatus. The lines may be represented by moveable threads, which can be readily adjusted at will so as to be parallel or to deviate from parallelism in varying degrees, the deviation being accurately measured by a scale. In this particular case, the solution of the problem has not been definitely reached, but there is no doubt that the quantitative method has far the best chance of success.

CHAPTER III.

BODY AND MIND.*

§ 1. *Physiological Antecedents and Consequents of Mental Process.*—It is an old saying that the body is the organ of the mind,—the instrument through which it works. This account of the matter is evidently true so far as regards the peripheral organs of sensation and motion. We cannot see without eyes, or hear without ears; we cannot move without muscles. But without sensation and motion the process of consciousness would be impossible. We can give no satisfactory account of the mental life without reference to the construction of the organs of sense and the impressions they receive from external agencies, or without reference to the mechanism of movement by which we act on the external world and change our spatial relations to surrounding objects. There is practically no difficulty in determining the nature of the relation between body and mind when we have in view on the bodily side only the peripheral instruments of sensation and motion. For all psychological purposes this must be regarded as a relation of interaction. Impressions on eye or ear produce modifications of consciousness, and conscious volitions produce muscular contractions. Serious difficulties arise only when

* This is not an easy subject. The student is recommended to do his best to understand this chapter on the first reading, but should certainly make a point of returning to it after having read the book through.

we push our inquiry further back, and examine the relation of nervous process to conscious process. Muscular contraction follows change in consciousness only when the muscle is excited by an impulse which has its origin in a disturbance of the grey matter of the nervous system. Similarly, impressions on the organs of sense produce sensations only when they set up an impulse which is transmitted to the brain. In this process some parts of the nervous system may be regarded as intermediate links. Consciousness is not immediately connected with the occurrences which take place in them. These occurrences are either antecedent conditions of the nervous changes which are directly connected with consciousness, or consequences ensuing from nervous change that is directly connected with consciousness. They thus constitute intermediate stages between change in consciousness and change in the peripheral organs, and inversely. The nervous mechanisms which fulfil this mediating function may be regarded, like the muscles or the senses, as organs in the service of mental process. The relation is one of interaction. Conscious volition produces change in the nervous mechanism, and change in the nervous mechanism, set up in the first instance by impressions on the organs of sense, produces changes experienced in consciousness as sensations. But the case is essentially different for those nervous processes which are connected with consciousness immediately, without the intervention of any other material occurrences. This unmediated connexion of neural and conscious occurrences is found mainly, if not exclusively, in the cerebral cortex, which is the highest part of the brain. "Viewed broadly, the brain is a mass of white matter, with nuclei of grey matter deeply imbedded in it, and with a sheet of grey matter, about one-fifth of a square meter in

area and between two and three mm. thick, covering the folds, fissures, and convolutions of its surface."* This overlying sheet of grey matter is the rind or cortex of the brain, and is in immediate connexion with conscious process. For our present purposes, we may without serious inaccuracy regard all processes taking place in other parts of the nervous system as connected with consciousness only so far as they are causes or effects of processes in the cortex. Before coming to the vital question of the relation between cortical process and conscious process, it will be convenient to give some account of those parts of the nervous structure which lie beneath the cortex.†

§ 2. *Function of the Sub-Cortical Nervous Mechanism.*— The portion of the nervous system which lies below the cortex is partly contained within the cranium. This portion consists of nuclei of grey matter imbedded in white matter. The nuclei of grey matter constitute what are called the sub-cortical centres. The white matter consists of nerve-fibres, serving to conduct impulses between the cortex and the sub-cortical centres, and between the sub-cortical centres themselves. Running through the trunk of the body, behind the viscera, there is another important portion of the nervous system—the spinal cord. At its upper end it enters the cranium, and this portion of it receives a separate name, and is called the *medulla oblongata*, or simply, the *bulb*. Nerve-fibres connect the muscles and the surface of the body with the spinal cord, and strands of nerve-fibre pass upwards along the cord itself to the sub-cortical centres.

* Dr. Waller, *Human Physiology*, p. 518.

† The student should make a point of reading the chapters on the nervous system in some good *Physiology*. Lessons I. and XI. in Huxley's *Elementary Physiology* (Macmillan & Co., price 4s. 6d.), and Ch. IX. in Davis's *Elementary Physiology* (Blackie's Science Text-Books, price 2s.),

These sub-cortical portions of the nervous system serve to convey and modify impulses passing between peripheral organs and the cortex; but they also discharge functions which are independent of their connexion with the cortex. They are organs of what is called reflex action. Reflex actions are such as take place in a fixed and uniform manner in response to an appropriate external stimulus. Without the actual presence of the external stimulus they do not occur, and whenever the external stimulus operates they occur inevitably and invariably, unless they are interfered with by the simultaneous operations of another external stimulus, or by processes going on in the cortex. Their typical characteristics are best seen when interference on the part of the cerebral cortex is excluded, which may be effected by simply removing the cerebral hemispheres from the brain of an animal. "We may perhaps broadly describe the behaviour of a frog, from which the cerebral hemispheres only have been removed, by saying that such an animal, though exhibiting no spontaneous movements, can, by the application of appropriate stimuli, be induced to perform all or nearly all the movements which an entire frog is capable of executing. It can be made to swim, to leap, and to crawl. Left to itself, it assumes what may be called the natural posture of a frog, with the fore limbs erect, and the hind limbs flexed, so that the line of the body makes an angle with the surface on which it is resting. When placed on its back, it immediately regains this natural posture. When placed

will put him in possession of the most essential facts. If he wishes to go more deeply into the matter, Dr. Waller's *Human Physiology* (Longmans, Green, & Co.), may be safely recommended. For the advanced student, Parts III. and IV. of Dr. M. Foster's *Text-Book of Physiology* (Macmillan & Co.) are necessary. What I have said in the text is the roughest possible sketch, and can only serve, at most, as a reminder.

on a board, it does not fall from the board when the latter is tilted up so as to displace the animal's centre of gravity; it crawls up the board until it gains a new position in which its centre of gravity is restored to its proper place. Its movements are exactly those of an entire frog, except that they need an external stimulus to call them forth. They differ, moreover, fundamentally from those of an entire frog in the following important feature: they inevitably follow when the stimulus is applied; they come to an end when the stimulus ceases to act. By continually varying the inclination of a board on which it is placed, the frog may be made to continue crawling almost indefinitely; but directly the board is made to assume such a position that the body of the frog is in equilibrium, the crawling ceases; and if the position be not disturbed the animal will remain impassive and quiet for an almost indefinite time. When thrown into water, the creature begins at once to swim about in the most regular manner, and will continue to swim until it is exhausted, if there be nothing present on which it can come to rest. If a small piece of wood be placed on the water the frog will, when it comes in contact with the wood, crawl upon it, and so come to rest. If disturbed from its natural posture, as by being placed on its back, it immediately struggles to regain that posture; only by the application of continued force can it be kept lying on its back. Such a frog, if its flanks be gently stroked, will croak; and the croaks follow so regularly and surely upon the strokes that the animal may almost be played upon like a musical, or at least an acoustic instrument. Moreover, provided that the optic nerves and their arrangements have not been injured by the operation, the movements of the animal appear to be influenced by light; if it be urged to move in any particular direction, it seems

in its progress to avoid obstacles, at least such as cast a strong shadow; it turns its course to the right or left or sometimes leaps over the obstacle. In fact, even to a careful observer, the differences between such a frog and an entire frog, which was simply very stupid or very inert, would appear slight and unimportant except in this, that the animal without its cerebral hemispheres is obedient to every stimulus, and that each stimulus evokes an appropriate movement, whereas with the entire animal, it is impossible to predict whether any result at all, and if so what result, will follow the application of this or that stimulus."*

The characteristic of reflex action which Professor Foster here emphasises is its lack of spontaneity—its thoroughgoing dependence on the actual present operation of a stimulus external to the nervous system. Experiments of the kind he describes have been performed on birds and rabbits as well as on frogs. The results are, broadly, similar, except that in the case of birds there is some appearance of spontaneity when the animal has had sufficient time to recover from the shock of the operation. But this spontaneity is too small in degree and too ambiguous in its nature, to invalidate the general conclusion that the function of the sub-cortical centres when working by themselves is almost wholly reflex. Closely connected with lack of spontaneity there is another and equally important characteristic of reflex action. It takes place invariably in the same way without being modified in accordance with the results of past actions. Whether it is accompanied by any sort of experience or not, we may at least affirm that it is characterised by the absence of the process of *learning* by experience.

* *Text-Book of Physiology*. By Dr. M. Foster. Sixth Edition. Part III., "The Central Nervous System," pp. 1000, 1001.

Lack of spontaneity, and lack of the power of learning by experience, do not necessarily imply the absence of all consciousness in the widest sense of the word. It would be very rash, therefore, to affirm dogmatically that the frog without its hemispheres is entirely devoid of any kind of feeling. Whether it is so or not is a question which has been much disputed, and we shall not here attempt to decide it. But there is one point which emerges clearly from the experiment: this is that the working of the sub-cortical mechanism, together with whatever consciousness may accompany it, is capable of taking place separately from, and independently of, processes in the cortex. If this happens when the hemispheres are removed, it may also happen when they are present. In so far as the sub-cortical centres operate independently of the cortex, any consciousness which may accompany their action will be disconnected from the consciousness which accompanies the action of the cortex. But the consciousness which accompanies intelligent action is associated with cortical process. Now intelligent consciousness, capable of learning by experience, constitutes, in all but the lowest grades of animal life, the main stream of consciousness. Thus, though the independent action of the sub-cortical centres may not be wholly unconscious, whatever consciousness it involves does not form part of the main current of mental life in man and the higher animals. Only when process in sub-cortical centres ceases to be separate and independent, and brings into play in a marked manner the action of the cortex, is it accompanied by conscious modifications which form part of the conscious life of the individual as a whole.

This is borne out by human experience. In cases of injury to the spinal cord, the functional connection between lower and higher parts of the cord may be destroyed.

If under these conditions the soles of the patient's feet are tickled, they will be jerked away; but the man himself is in no way aware of what takes place, except as he might be aware of the movement of a foreign body. Quite apart from pathological conditions of this sort, reflex actions are constantly going on, which do not involve in any appreciable way the consciousness of the individual as a whole. The pupil of the eye is constantly contracted and expanded in accordance with varying degrees of illumination. In eating, morsels of food are swallowed by reflex action. We are constantly breathing in the same reflex way. These and similar processes can and do go on while the consciousness of the individual is pre-occupied with other matters. On the other hand, there are certain reflex actions, such as sneezing, coughing, and withdrawal of the hand, when suddenly burned or scalded, which usually involve consciousness. A sneeze, for instance, produced by Cayenne pepper, can hardly take place unconsciously. But whenever such actions are unmistakably accompanied by consciousness, it is evident that the stimulus which produces them excites in a conspicuous way the cortex as well as the sub-cortical centres. Intelligent attention is either brought to bear on the situation, or it is disturbed and deranged by the violence of the shock. When a pin is suddenly plunged into a man's leg, he jumps, by reflex action. But at the same time, there is a marked disturbance of his intelligent consciousness. The train of thought, with which he may have been pre-occupied at the moment, is broken off and his whole mental attitude changed. The sensation which introduces a sneeze has not the same violent disturbing effect; but so far as it is conspicuously accompanied by consciousness, it tends to attract attention and to

produce intelligent adaptation to circumstances. The man pulls out his handkerchief, or the like. When the main stream of consciousness is very intently pre-occupied, external stimulants which would otherwise excite cortical process, fail to do so and merely produce reflex action of which the individual is unconscious. Thus, when we are much pre-occupied with some absorbing object, we may cough or yawn without being aware of it. From the facts we have stated, we may conclude that the cortex is pre-eminently, if not exclusively, the seat of those processes which are immediately correlated with individual consciousness.

Besides being a mechanism of reflex action, the sub-cortical centres constitute an apparatus by means of which the cortex produces movements of the organism. The mechanism for the relatively simple constituents of complex activities is contained in the sub-cortical centres. The complex activities are produced by the cortex playing upon the lower centres, so as to evoke the simple constituent movements in a certain order, simultaneous and successive. It is, above all, the successive co-ordination of movements which is due to the cortex. Simultaneous co-ordination of a complex kind is involved in many purely reflex actions.

From a biological point of view, the function of the cortex is adaptation to irregularly varying conditions. Reflex action will suffice to maintain the life of an animal which has merely to perform simple actions in a uniform way on the recurrence of uniform external conditions. But where fluctuating adaptation to fluctuating conditions is required, reflex action becomes inadequate, and often actually harmful. Action must be varied in correspondence with the results of previous action, so that it may not be

repeated in circumstances under which it has proved injurious. For this, intelligence, and the nervous organization correlated with intelligence are required. The burnt child shuns the fire, and so saves itself from future burns; but the moth will dash again and again into the candle-flame, though it is singed every time. The moth's action is reflex, that of the child is intelligent.

§ 3. *Immediate Correlation of Conscious and Nervous Process.*—In the cortex at least we have a direct relation between nervous process and conscious process, and are so brought face to face with the question of the ultimate nature of their connexion. To some extent this is a question of fact, and can be settled by special evidence. But there is also a wide field for speculation, in which we cannot be at all certain of our conclusions.

The facts show that there is not only a general correlation between conscious process as a whole and cortical process as a whole, but also that special parts of the cortex are connected with special constituents of the mental life. A generation ago the prevailing doctrine among physiologists was opposed to this "localisation of function," as it is called. It was held that the cortex discharged each of its separate functions as a whole, so that injury done to it, or removal of part of its substance, did not involve the loss or impairment of any special mental process rather than any other. The only result was a general impairment of mental power. Just as a man still breathes as before when he has only one lung, except that he does so less efficiently, so it was supposed that a part of the brain might in the same manner be substituted for the whole. On the other side, the phrenologists maintained a very definite theory of localisation. But their doctrine was a mass of psychological and physiological crudities. They

mapped out the brain into organs corresponding to complex faculties, such as acquisitiveness, combativeness, ideality, orderliness, constructiveness, and the like. Such a scheme is a psychological absurdity. Each of these faculties involves the coöperation of a vast number of fundamental processes, and the same processes enter in varying combination into the constitution of the different faculties. Thus the procedure of phrenology is like that of a man who should assume a different board and a different set of pieces for every game of chess, or a separate alphabet for every word. Besides this there is a very obvious anatomical objection against the supposed evidence adduced by the phrenologist. This consisted in the reading of character by the feeling of bumps; but as a matter of fact, the external conformation of the skull is far from accurately corresponding to the development of the brain.

But the most crushing refutation of phrenology is supplied by what has been ascertained in recent years about the modes in which cerebral functions actually are localised. So far as the cortex has been mapped out on good evidence, it is found that the division of function among different parts corresponds, not to complex faculties, but to the bodily organs of sensation and movement. One portion of the cortex, anatomically connected with the eye, is specially correlated with visual consciousness, in the way of sensation or mental imagery. Another, anatomically connected with the ear, has a similar relation to auditory experience. Another is specially connected with touch-sensations, and with movements of the limbs. The evidence on which these conclusions are based is partly gathered from experiments on animals, and partly from pathological data. The pathological evidence is most

important and unambiguous. Diseases affecting communication of ideas by means of language have been especially useful. Under the general name *aphasia* are embraced many defects of varying kinds. The patient may be simply unable to articulate words, although he can understand them when he hears them. This is motor aphasia, and it has been definitely connected with lesion of a special part of the brain called the third frontal convolution.* Again, a man may be able to articulate, and yet lack the power to distinguish words as such when he hears them. He hears them indeed as a confused stream of sound, but they are not for him words. This is sensory, or, more accurately, perceptual aphasia, and it is connected with lesion of a special portion of the auditory area of the cortex. Similarly, inability to recognise written words for what they are is connected with lesion of a special portion of the visual area. These indications may serve to show what is meant by localisation† of cerebral functions, and the methods by which it is determined. But it must be remembered that our ignorance is still incomparably greater than our knowledge. The student must also be warned against supposing that localisation is definite and precise in its nature. "The various activities making up the business of the brain do not take place all over its surface, as in a country without towns and villages, where all kinds of industry go on in every hut or tent; nor are the different activities absolutely restricted to certain spots, as if in walled towns. The brain cortex is

* Of the left hemisphere in right-handed persons, and of the right hemisphere in left-handed persons.

† In localisation what is locally marked off is a certain portion of the brain and the material processes which take place in it. The corresponding conscious process is not, strictly speaking, localised. The nature of its connexion with the localised brain-process remains to be discussed.

not comparable with either of these extreme cases; its territory must be recognised as possessing towns with special industries, but towns with straggling and overlapping suburbs, and industries that are, indeed, predominant each in a given centre, but not exclusive of all other industries in that centre, nor excluded from other centres in which other industries predominate."*

Data of the kind described afford us no efficient help when we come to consider precisely how cortical process is related to the corresponding conscious process. There are, in the main, three alternative possibilities,—interaction, one-sided action, and simple concomitance. On the interaction hypothesis, a cerebral process may produce a state of consciousness, just as a nervous process may produce a muscular contraction, or as change in one part of the cortex may produce change in another part; and, inversely, a conscious process, such as a volition, may act on the cortex, just as the cortex acts on sub-cortical centres, and these on the muscles.

The main objection to this view is that the kind of interaction pre-supposed is utterly incongruous with the conception of causation on which the whole system of our knowledge both of physical and psychical process is based. It is the function of science to explain how events take place, or, in other words, to make their occurrence intelligible; but this is only possible in so far as we can discover such a connexion between cause and effect as will enable us to understand how the effect follows from the cause; or, in other words, we must exhibit cause and effect as parts of one and the same continuous process. To explain is to exhibit a fact as the resultant of its factors. This is the ideal of science, and it is never completely

* Waller's *Physiology*, pp. 534-535.

attained. But in so far as it is unattained, our knowledge is felt to be incomplete.

Now when we come to the direct connexion between a nervous process and a correlated conscious process, we find a complete solution of continuity. The two processes have no common factor. Their connexion lies entirely outside of our total knowledge of physical nature on the one hand, and of conscious process on the other. The laws which govern the change of position of bodies and of their component atoms and molecules in space, evidently have nothing to do with the relation between a material occurrence and a conscious occurrence. No reason in the world can be assigned why the change produced in the grey pulpy substance of the cortex by light of a certain wave-length should be accompanied by the sensation *red*; and why that produced by light of a different wave-length should be accompanied by the sensation *green*. It is equally unintelligible that a state of volition should be followed by a change in the substance of the cortex and so mediately by the contraction of a muscle.

The same difficulty is felt from a practical as well as from a theoretical point of view. The physiologist, in his endeavour to make organic processes intelligible, by connecting them with the general order of physical nature, cannot but regard the presence of a factor which does not enter into this order as a most serious stumbling-block, which may upset all his calculations. A favourite way of putting the objection from this point of view, is to say that the intervention of conscious process in physiological process would contradict the law of conservation of energy. This is not strictly true, because the conservation of energy is a law framed expressly for a material system; when a factor is introduced which is not material, though the law

may not be applicable, it is not violated. Apart from interfering conditions stones will fall to the earth; this law is not violated when I lift a stone in my hand. Similarly no change in the material world, as such, produces loss or gain of power to do work; the power being merely transferred from one portion of matter to another. Nevertheless, it is quite conceivable that loss or gain of energy might ensue from the operation of a factor which does not belong to the material world at all. But, though no contradiction is involved in such a supposition, it is clear that the fresh creation of material energy by conscious process would introduce an incalculable and disturbing factor, seriously interfering with the work of scientific discovery and explanation. Nor is this objection limited to the law of conservation of energy; it applies to all the ultimate principles on which our knowledge of the physical world is based. So far as the conservation of energy is concerned, it might be supposed that there is a transfer of energy from material process to conscious process. Physical energy might be transformed into intensity and complexity of consciousness, and *vice versâ*. But there is no sufficient evidence of this, and all that we know points in the contrary direction. Intensive quantity is not measurable and calculable in such a way as to make it comparable with other forms of energy. The hypothesis of interaction, it is clear, labours under very serious difficulties, and though it cannot be pronounced impossible, yet it will be well to avoid it, if we can find some alternative which is on the whole more tolerable.

To the second alternative, one-sided action, either of matter on mind, or of mind on matter, the theoretical objections which have been brought against interaction apply with equal force. It also involves the additional

difficulty that all other action with which we are acquainted, is interaction. One-sided action would therefore be contrary to our general experience of the order of nature. Yet the hypothesis that matter causally determines consciousness, without being itself determined by consciousness, is one which has so much currency that it requires special criticism. This doctrine of *materialism*, as it is called, seems incapable of any precise statement; whatever plausibility it possesses, arises from the use, or rather from the misuse, of the word *function*. Digestion is a function of the alimentary canal; breathing is a function of the lungs; why cannot we simply affirm that consciousness is a function of the brain? The objection is, that we do not make two things the same by applying the same word to them, when in their own nature they are radically and essentially different. When we say that digestion is a function of the stomach, we mean that digestion is the stomach engaged in digesting. When we say that breathing is a function of the lungs, we mean that breathing is the lungs at work. In describing the process of digestion, we, *ipso facto*, describe the stomach itself as engaged in the process. In describing the process of breathing, we, *ipso facto*, describe the lungs as filling themselves with air by a certain movement, and expelling it by an alternate movement. But if we describe the brain at work, there is no need to mention consciousness at all; and in naming and describing conscious processes, there is no need to mention the brain. The function of the brain as a physiological organ is to move the body; the contraction of muscles is the result of neural impulses; and in describing it we have to mention the nervous system, including the cortex, as engaged in it. But the process of consciousness cannot be analysed or resolved

into such processes as chemical and physical changes in nerve-cells. If consciousness is supposed to be produced by the nervous process, the production is simply creation out of nothing. An objection of an equally serious kind is that the materialistic theory destroys all possibility of agency on the part of conscious beings. According to it, the appearance of causal connexion within the process of consciousness itself is an illusion; no judgment was ever due to a train of reasoning; no volition was ever due to motives. The sole cause in every case was a certain modification of the nervous system. Similarly conscious process can, on this view, never determine external action. No man ever lifted a finger because he willed to do so. No tears were ever the consequence of emotion. This question is sometimes confused by the supposition that materialism would only interfere with what is called free-will; in truth, it makes impossible any real operation of consciousness of any kind whatever. The logical consequence is not only that man as a conscious being never does anything freely, but that no man ever does anything at all.

We now come to the third hypothesis. This differs both from the theory of interaction and from materialism, inasmuch as it separates the statement of facts from theoretical explanation. Its first problem is to state the facts without implying direct interaction between nervous and conscious change, and without implying that the one creates the other. The formula which it uses for this purpose is that of psycho-physical parallelism, which simply states that modifications of consciousness emerge contemporaneously with corresponding modifications of nervous process. The nervous changes are supposed to be parts of the total continuous process of the physical universe, so that science will require none but material conditions to

explain them. On the other hand, there is causal connexion within the process of consciousness itself, as such. This psychical causation runs parallel with the material, but is not itself material. When a bodily action, such as moving a finger, follows upon volition, it is the cortical process concomitant with the volition which sets the muscles in contraction and so produces the movement. When an external impression is followed by a sensation, what the external impression produces is a cortical process, which is concomitant with but does not cause the sensation. The external impression may be regarded as if it were a cause of the sensation, inasmuch as it is a cause of the cortical process correlated with the sensation. Similarly, the volition may be regarded as if it were a cause of the movement, inasmuch as it is correlated with the cortical process which sets the appropriate muscles in contraction. This account of the matter covers the facts as they are known to us; but it is merely a way of formulating these facts; it is not an explanatory theory. On the contrary, if it is a true formulation of the facts it is evident that these facts do not contain their own explanation. If the concomitance of cortical and conscious process is regarded as an ultimate principle, it is simply a miracle. That the cortical process which sets in motion the muscles moving the finger should happen to be accompanied by the conscious volition to move the finger without causal connexion between them, is in itself utterly unintelligible. If we are to find an explanation, we must frame some hypothesis to account for psycho-physical parallelism, and in so doing we are compelled to plunge into ontology.

§ 4. *Metaphysical Explanation of Psycho-Physical Parallelism.*—If the doctrine of psycho-physical parallelism is true, the reason of the connexion between conscious process and

the correlated nervous process is not to be found in the nervous and conscious processes themselves. Both must be regarded as belonging to a more comprehensive system of conditions; and it is within this system as a whole that the reason of their connexion is to be sought. In particular, the individual consciousness, as we know it, must be regarded as a fragment of a wider whole, by which its origin and its changes are determined. As the brain forms only a fragmentary portion of the total system of material phenomena, so we must assume the stream of individual consciousness to be in like manner part of an immaterial system. We must further assume that this immaterial system in its totality is related to the material world in its totality as the individual consciousness is related to nervous processes taking place in the cortex of the brain. Within the immaterial system the individual consciousness is a determining factor: within this system it acts and is acted on. But this interaction is virtually interaction between conscious process and the material world: for the total immaterial system to which the individual consciousness belongs is correlated with material phenomena in general, as the individual consciousness is correlated with nervous occurrences in the cortex. When a volition sets the finger moving, the volition acts within *its* own sphere of influence, and the corresponding cortical process acts within *its* own sphere of influence.

We have yet to consider the relation of the immaterial system as a whole to the material system as a whole. If this relation be regarded as one of mere parallelism or concomitance, the fundamental difficulty, so far from being removed, is aggravated. To obtain light on this ultimate question, we must take an entirely new point of departure. We must consider the problem of the ultimate nature of

matter. To do so here at length is of course impossible; but we may say that the explanation of psycho-physical parallelism is ultimately based on an idealistic view of material phenomena. The sensible qualities of matter exist only for minds which have certain experiences in the way of sensation. The extension, configuration, and other qualities of material bodies all pre-suppose the existence of certain modes of conscious experience. In like manner, the ultimate constituents of matter as they are recognised by scientific theories are abstract constructions of the human mind. In general, all that makes matter material presupposes some consciousness which takes cognisance of it.

Matter, as perceived and conceived by common sense and science, is essentially a phenomenon; and *phenomenon* simply means *appearance* or *presentation*. There can be no appearance or presentation apart from a subject to which an object appears or is presented. Hence the nature of matter as known is constituted by its being known, or at least knowable. On the other hand, it is equally certain that the *existence* of what is known to us as matter does not depend on our knowledge of it. We do not make matter. Only its appearance as material phenomenon is dependent on us. Hence it follows that, so far as it exists independently of its presentation to a cognitive subject, it cannot have material properties, such as extension, hardness, colour, weight, and the like. It is an agency which is an essential condition of material phenomena, but is not itself a material phenomenon. Thus we are led by a quite different line of investigation to the same conclusion which was suggested by the relation of conscious process to nervous process. The world of material phenomena presupposes a system of immaterial agency. In this immaterial system the individual consciousness originates. To

it, in some way, the sensational experiences are due which form the basis of our knowledge of the material world. It is on it the individual consciousness acts when it produces changes in the material world. All this is possible because the system of immaterial agency is identical with what we know as matter, in so far as matter exists independently of its possible presentation to a perceiving subject. This theory has been purposely stated in a vague form. There are varying views as to the nature of the system of immaterial agency. Some say that it is will, others that it is absolute thought, others that it is unknowable; in any case, the student should guard against the assumption that the immaterial system is a sort of repetition of the material system, involving the same sort of interactions, and similar distinctions and relations of its parts. One thing seems clear,—that we are nearer the truth in speaking of it as consciousness, than in speaking of it as matter.

§ 5. *Conclusion.*—We have discussed three theories of the immediate connexion between conscious and nervous process. Of these, what we have described as materialism must be rejected. The other two, interaction and parallelism, have each advocates among the best psychologists and metaphysicians of the present day. The student is recommended to avoid hastily deciding between them. The hypothesis of parallelism is that to which we are ourselves inclined. It certainly covers the known facts, and forms the most convenient working hypothesis. It escapes the difficulties which attach to the theory of interaction. But it must be admitted that it does so only by somewhat bold speculation.

For psychological purposes the doctrine of psychophysical parallelism is, as we have said, a sufficiently good

working hypothesis, if we take it merely as a mode of formulating facts. We shall accordingly assume its validity in this work. In indicating the theoretical explanation of psycho-physical parallelism we have passed beyond the limits of psychology proper, and entered upon ontological speculation. It has been thought advisable to adopt this course for two reasons: first, because the intelligent student always feels a keen interest in the relation between body and mind, and cannot, as a rule, rest satisfied with the statement of the simple concomitance of nervous and mental processes. In the second place, theories on the subject are in the air and are put forward in a more or less dogmatic fashion by popular writers. Hence a mere attempt to give a formula for the facts is apt to be interpreted as a decision in favour of one or other of these theories. To avoid being misunderstood it is necessary to be explicit. But the reader should take note that we do not pretend to have given more than a general indication of the main lines of thought on this profoundly important topic.

BOOK I.

GENERAL ANALYSIS.

CHAPTER I.

ULTIMATE MODES OF BEING CONSCIOUS.

§ 1. *Introductory.*—Human consciousness is normally concerned with some object or other. In waking life, we are usually, and perhaps always, perceiving something or thinking about something. Now there are three ways in which our consciousness is related to its object. (1) We have some kind of cognisance of the object; (2) we feel pleased or displeased with it, or otherwise emotionally affected towards it; (3) we experience a tendency in some way to alter or transform it, either by bringing it more fully into consciousness, or the reverse. Thus, we may say that there are three ultimate modes of being conscious of an object: knowing, feeling, and striving; the cognitive attitude, the feeling attitude, and the conative attitude. These three are normally and in all probability always united in the same total state of consciousness. They are not distinct states which succeed each other in time; they are partial constituents of one concrete whole.

§ 2. *Cognition.*—The word *cognition* is here used in a very wide sense. It covers all modes and degrees of being aware of or cognisant of an object. The word *object* must

not be taken to mean merely material object, but whatever we can in any way be aware of or cognisant of. The book I see before me on the table is an object to me, inasmuch as I perceive it. The immortality of the soul is also an object to me whenever I think of it. *Nothing* is an object to me, whenever I use the word *nothing* and attach a meaning to it; so is a Centaur when I imagine one. To perceive or think at all is to perceive or think of something, and this something, just because it is perceived or thought of, is an object presented to consciousness.

The use of the words *presented* and *presentation* requires to be explained. Whenever we perceive or think of an object, the object must have its specific nature by which it is distinguishable from other objects. Now the specific nature of the object as perceived or thought of presupposes a correspondingly specific modification of the individual consciousness which perceives or thinks of it. As the stream of consciousness successively takes cognisance of various objects, it must itself pass through correspondingly varying states. The distinctive nature of the object is apprehended only in so far as the object is qualified by the specific modifications of consciousness which exist in the moment of cognition. This leads up to the definition of the word *presentation*. Whatever constituents of our total experience at any moment directly determine the nature of the object as it is perceived or thought of at that moment, belong to the cognitive side of our nature, and are called *presentations*.

Suppose that what I perceive at a given moment is a sensible quality, such as the colour red. Without having the sensation *red* I could not perceive the sensible quality *red*. The sensation of *red* is therefore a presentation of the sensible quality. Here a difficulty will no doubt occur

to the student. Why do we distinguish between the sensation and the sensible quality? Why do we not say that the sensation is itself the object? There is one obvious consideration which makes plain the need for this distinction. I can perceive the sensible quality again and again on different occasions, and identify it as the same. But on each separate occasion I have a separate sensation. The sensations are so many distinct events or occurrences in the history of my individual experience. The sensible quality is not an event in the history of my experience at all. It is an object which may be perceived and identified as the same in many different phases of my life-history widely separated in time. The same distinction becomes still more obvious if we take other instances. If I perceive a triangle, my perception is not triangular,—it is not made up of lines and angles. On the other hand, the triangle as it appears to me when I see it is not an occurrence in the history of my individual consciousness; it is a geometrical figure, which is a very different thing. Again, in a moment of time I may think of eternity: it is obvious that the specific modifications of consciousness which exist while I am thinking of eternity, and disappear after I have ceased to think of it, are not themselves eternity or eternal. Similarly, I may think of non-existence; this is an actually existing thought; and the specific modes of consciousness which give it its specific nature must actually exist. They cannot therefore be identified with the object of the thought, which is non-existence.* The object itself can never be identified with the present modifications of the individual

* It may nevertheless be true that in distinguishing between presentation and presented object we are in a sense counting the same thing over twice. Doubtless they form an inseparable unity; but for psychological purposes the distinction must be made. If we are counting the same

consciousness by which it is cognised. This holds true even when we are thinking about modifications of our own consciousness. The conscious experience in which we think of another conscious experience is always at least partially distinct from the conscious experience of which we think. "Whenever we try to think of an immediate experience of our own, as such, we can do so only by investing it with attributes and relations which are not themselves immediately experienced at the moment. For example, I may think of a momentary appearance in consciousness as an occurrence in my mental history, an incident in my experience. But neither my experience, as a whole, nor the positions and relations of any part within that whole can be given as a transient phase of individual consciousness. The momentary consciousness is only one link in the series which constitutes my experience."*

Though cognitive consciousness and its object are not to be identified, they are none the less intimately correlated. Differences in the nature of the object as presented presuppose correspondingly differentiated modifications of consciousness. These special modes of subjective experience which define and determine the direction of thought or perception to this or that special object are *presentations*. "We may say, if we choose, that the object itself is *presented*, but we must not say that it is a presentation; and when we say that it is presented, it is better to say that it is presented *to* consciousness, than that it is presented *in* consciousness. In the perception of a tree the reference

thing over twice, we are at least regarding it from two essentially different points of view. In the one case we are regarding it as qualifying the object of which the individual consciousness is cognisant: in the other, we are regarding it as qualifying the stream of individual consciousness itself.

* *Analytic Psychology*, vol. i., p. 44.

to an object is circumscribed and directed by a plexus of visual and other presentations. The object thought of is thereby made determinate. It is a material thing and not a mental occurrence, a tree and not a stone, an oak and not an elm."*

§ 3. *The Feeling-Attitude.*—Besides having cognisance of an object, we are usually, if not always, pleased or displeased, satisfied or dissatisfied with it, and sometimes partially the one and partially the other. This feeling-attitude pre-supposes the existence of cognition. We cannot feel pleased or displeased with a thing when we have no cognisance of it. Even when we have no cognisance of it, it may produce an agreeable or disagreeable feeling in us; but this causal relation is quite different from that between subject and object. We may feel displeased with a glaring light. Doubtless our displeasure is caused by vibrations in the luminiferous ether; but if we know nothing of these vibrations, we cannot say that they are the object of our displeasure†, in the psychological meaning of the word *object*. Therefore, from a psychological point of view, we cannot say that we feel displeased with them.

Can our total consciousness at any moment be entirely devoid of pleasure and displeasure? This is a question which we may be at first sight tempted to answer decidedly in the affirmative. I may, it would seem, perceive a stone, or a clod of earth, or a geometrical diagram, without feeling either agreeably or disagreeably affected towards these objects. But the apparent plausibility of this answer disappears when we look more closely into the case. Why do we notice these

Analytic Psychology, vol. i., p. 47.

† The term *displeasure* is ordinarily used to signify *resentment*. In this work we make it signify simply the opposite of being pleased. The term *pain*, as we shall see later, is ambiguous.

objects at all? Perhaps we do so merely with the view of settling by experiment the question we are now discussing. But if that be so, the issue of the experiment itself is more or less satisfactory or unsatisfactory. We are in some degree pleased that our own pre-conceived view is confirmed, or displeased because it is apparently upset. If we have no pre-conceived view, we are pleased or displeased because we do or do not succeed in obtaining an answer to the question proposed. Thus, the affirmative answer turns out under these special conditions to be due to an oversight. We have not taken into account our total consciousness in relation to the object, but only a small and unimportant part of it. Now, suppose that, instead of having a pre-existing motive for noticing the object, we simply take cognisance of it because it happens to pass before our eyes. Here it may be said that we are purely neutral in regard to it. But there are many things presented to our bodily vision of which we take no cognisance. The more pre-occupied we are, the more entirely they escape notice. If this or that object so obtrudes itself when our minds are pre-engaged on some other topic as to divert the current of our thoughts, it must have some interest of a pleasant or unpleasant character. If it does not divert the current of our thoughts, the cognisance we take of it will be slight and transient, and will form only a small and insignificant portion of our total consciousness. Thus our total consciousness may involve pleasant or painful interest, although this small portion of it does not contribute in any appreciable degree to its pleasantness or unpleasantness. Again, our minds may be comparatively disengaged, so that they are free to attend to surrounding things; but it is the characteristic of these idle moods that we are more or less amused or bored by

the trivial objects which obtrude themselves on our senses. On the whole, the presumption appears to be that our total consciousness is never entirely neutral. The student must here be warned against a common fallacy: we are apt to suppose that we are only pleased or displeased, when we expressly notice, at the time, that we are, or remember afterwards that we have been, pleased or displeased. But in fact we only notice or remember when the pleasantness or or unpleasantness is specially conspicuous. There is a customary level of agreeable or disagreeable feeling which we are apt to treat as a neutral state. In like manner, we do not notice that we are hot or cold, unless we feel more hot or cold than usual. Similarly, what we call silence is not absolute silence, but only a comparative absence of sound. This is shown when we pass from what we call silence to a still more complete absence of sound. The previous state then ceases to appear to us as one of silence. As a matter of fact, sound of some sort is never wholly absent from our experience. The same is in all probability the case with pleasure or displeasure. One or the other or both, are always in some degree present, although we by no means always notice their presence.

When we wish to say that pleasure or displeasure belongs to this or that mental process, we say that the process is pleasantly or unpleasantly toned. *Feeling-tone* is a generic word for pleasure and pain. It is less ambiguous than *feeling* alone, which not only has many other applications in ordinary language, but even in psychology is to some extent required for other purposes. Hence, as a technical expression, we shall henceforward speak of feeling-tone when the reference is to pleasure-pain.

Are there other kinds of feeling-attitude besides

pleasure and displeasure? It would seem that there are. It is difficult to bring emotions, such as anger and fear, and sentiments, such as love and hate, completely under any other head. Certainly, an emotion, like anger, involves some kind of cognition; but it cannot be said that the specific experience of being angry directly qualifies the nature of the presented object; in other words, this experience is not a presentation. So, too, anger has feeling-tone, mostly of an unpleasant kind. But its specific quality cannot be resolved into pleasure or displeasure. Again, it involves certain characteristic active tendencies; but there is in it a peculiar and unanalysable mode of being conscious, which cannot be resolved into these. We must, therefore, conclude that in the complex emotion of anger there is included a specific feeling-attitude distinct from being pleased or the reverse. The same may be said of the other emotions.

§ 4. *The Conative Attitude.*—The states designated by such words as *craving*, *longing*, *yearning*, *endeavour*, *effort*, *desire*, *wish*, and *will*, have one characteristic in common. In all of them there is an inherent tendency to pass beyond themselves and become something different. This tendency is not only a fact but an experience; and the peculiar mode of being conscious, which constitutes the experience, is called *conation*. The process of consciousness is a process of incessant change; the changes are partly due to the play of external impressions, and to other conditions extraneous to consciousness itself. But this is rarely, if ever, entirely so. The process is in part self-determining. The successive phases have, by their very nature, a tendency to pass into other phases. The stream of consciousness has a current; and its course is determined not merely by external conditions, but by its own drift at any moment. Considered in relation to the presented object, conation is a tendency

to alter it, or make some difference in it, to expel it from consciousness, or to bring it more vividly and completely before consciousness.

Mental activity also produces or tends to produce changes in the body and in the external world. But we must carefully separate these changes from conation. They are merely means by which it may work. The end to which it is directed is always some change in consciousness itself. If I will to blow a candle out, the mental activity does not lie in the contraction of my muscles, nor yet in the effect produced on the candle as a physical occurrence. It is the resulting darkness, in so far as I am aware of it, which is the end attained by my volition. In other words, it is a change in the object, as *presented*, which I strive to attain in willing to blow out the candle. It is not necessary that I should have actual experience of the physical result. I may make a will, leaving property to a certain person. Here, what I am aiming at or endeavouring after is that this person shall enjoy my property after I am dead. By the nature of the case, I can have no direct experience of the result. What satisfies me and so terminates the volitional process is the *belief* that my property will actually come into the hands of the legatee. Before I made the will, this was only a floating possibility. In making the will, I transform it into a practical certainty.

It may happen that the end to which conation is directed is, from the nature of the case, unattainable. Thus, I may wish to recall or undo the past. This is a tendency which cannot realise itself. But none the less it is a tendency as much as if it could realise itself. Considered as a mode of consciousness, it is just as much a conation as the desire to blow out a candle standing before my eyes.

Conation may attain its end by merely mental process,

without overt bodily action. In part or whole, it may be satisfied by fuller knowledge of its object; and this may be brought about merely by a train of thought or observation, without altering the nature of the object as it actually exists apart from its being presented to consciousness. From this point of view we can bring under conation all that is covered by the word *attention*. Attention is simply conation in so far as it finds satisfaction in the fuller presentation of its object, without actual change in the object. This may be possible only in part. Thus, we may have a practical end in view, and we may, for the sake of this end, attend to the conditions and means of its attainment. I may wish to climb a rock, and I first observe it carefully to determine the best mode of ascent. So far, all I have gained is more complete knowledge. This is a partial satisfaction of my original desire. It carries me a stage nearer to my end; but it does so only because it makes further steps possible. On the other hand, my interest may be purely theoretical. I may simply desire to know the geological structure of the rock. In this case, mere observation will be sufficient. If it is necessary to climb the rock, the climbing will be merely a means of making observation possible, just as in the previous case observation is merely a means of making climbing possible. Sometimes it would appear as if attention were not directed to the fuller presentation of an object, but merely to the keeping of it unchanged before consciousness. "Perhaps the closest approximation to this mental attitude is found in the case of attention to a simple object of sense or imagination, on account of the immediate pleasure it yields."* Now we allow here that the end of attention is not cognitive; none the less, its end is in a sense

* *Analytic Psychology*, vol. i., pp. 126-7.

the fuller presentation of the object. So long as the pleasure-giving capacity of the object is not exhausted, it makes a difference to consciousness whether it continues to be presented or not. It is only fully presented when consciousness is satiated.

We have repeatedly used the word *end*. Conation is the intrinsic tendency of a state of consciousness to pass beyond itself into a different state. Just in so far as the tendency is realised, it ceases to exist, or in other words, finds its end. When it is completely realised its end is completely attained, and it completely disappears. Hunger disappears after a full meal; intellectual curiosity disappears when a problem is solved, and so on. Thus the word *end*, used in reference to conative tendencies, whatever else it may imply, implies also its ordinary literal meaning. The end after which consciousness strives, is, when attained, the termination of the striving. This is a point to which we shall have to refer later. It is obscured by two circumstances. The first is, that there are some ends, such as the moral ideal, which can never be completely attained. The second is, that while we are actually striving after the end, we think about its own positive nature, and not about the psychological result which would follow its complete achievement. We do not consciously strive after the cessation of our own activity, except when we try to go to sleep or when in any other way we endeavour after repose. None the less, it remains a fact that the complete achievement of any end means the complete cessation of the special activity directed towards that special end.

As feeling-tone has two phases, pleasure and displeasure, the first positive and the second negative, so conation has a positive phase, *appetition*, and a negative phase, *aversion*. It is either directed to maintain and further develop a

presented object, or the reverse. To use a phrase of Hobbes, it is either an endeavour *towards* or an endeavour *fromwards*. Appetition by no means coincides with pleasure, or aversion with displeasure. We may feel a very keen desire for an object, and yet feel nothing but displeasure if we are delayed or obstructed in its attainment. I may desire food, and this is a positive conation. But if no food is to be had, the feeling-tone of consciousness will be disagreeable. So we may have an aversion to the presence of a person; and this is very unpleasant if we cannot get rid of him; but it may be very pleasant, if we can throw him out of the window, or kick him downstairs. It is worth while to note this point, because it disposes of certain attempts which have been made to identify conation with feeling-tone.

We have finally to deal with the question whether conation in some form or degree is invariably a constituent of consciousness. The problem is beset with the same difficulties as in the case of feeling-tone, and similar remarks apply here also. We are apt to assume that consciousness is absolutely inactive, when it is only comparatively so. We only notice that we are endeavouring after an end, when our endeavour rises above a certain pitch of intensity. Thus we do not generally say that our consciousness is active when we happen to catch sight of an object and attend to it in a slight and transient way. None the less, conation may be, and probably is, present in this case, as well as in the most intense mental effort. The best mode of approaching the question introspectively is by comparing different degrees of conative tendency; a state of consciousness which, taken by itself, would appear to be purely passive and inert, ceases to appear so when it is compared with one which is still more passive and inert.

"Take, for example, the following series: (1) In a state of delicious languor I enjoy the organic sensations produced by a warm bath. (2) In an indolent mood, I let my eye wander from object to object, and amuse myself with what I see, without any definite plan or purpose. (3) Without plan or purpose, I give the rein to my own ideas, following the train of more or less casual associations. (4) I repeat the multiplication table, or work out some simple arithmetical question of a familiar kind. (5) I work out an arithmetical question which is more of a task because it is more complex, though it is of a familiar type, and presents nothing in the nature of a puzzle. (6) I attempt an arithmetical question which for a time baffles me, because it contains a difficulty which requires to be overcome by repeated trials. (7) In a critical point of my career I endeavour to decide between two courses of action,—the whole course of my future life being dependent on the decision. Of these, (7) is a mental state characterized by a far more intense feeling of activity than (1); and (2), (3), (4), (5), (6) constitute an ascending scale of transitions mediating between them."*

We must distinguish between activity and the feeling of activity. The only question which introspection can consider is whether we always have some immediate experience of striving, or tendency towards an end. Even if this question is answered in the negative, it may still remain true that conscious process, as a matter of fact, always involves tendency towards an end, though the tendency is not always a mode of being conscious.

§ 5. *Sentience or Sub-Consciousness.*—We have so far considered consciousness only in its relation to presented objects. But if we analyse our total experience at any

* *Analytic Psychology*, vol. i., pp. 160-1.

moment, we shall find in it much material which is not at the moment contributing to the cognitive function of consciousness, and is to that extent without objective reference. It is the special function of presentation to present objects; but those modifications of consciousness which are capable of fulfilling this function may exist even when they are not the means of cognising objects. "They may exist as possible material for discriminative thinking without being actually utilised to the full extent in which they are capable of being utilised. At this moment I am thinking about psychological topics. I receive at the same time a multitude of diversified impressions from surrounding things which certainly enter into my total experience. But if I refer them to an object at all, I do so in a very indeterminate way. My thought-discrimination is very far from keeping pace with the differentiation of the sensory data as immediately experienced. To quote Abraham Tucker: 'We may see leaves falling from the trees, birds flying in the air, or cattle grazing upon the ground, without affirming, or denying, or thinking, anything concerning them; and yet, perhaps,....upon being asked a minute afterwards we could remember what we had seen. A man may have beheld a field from his window a hundred times without ever observing whether it were square or pentangular, and yet the figure was exhibited to his view every time he looked upon it'....A single sweep of the eye takes in an indefinite multitude of details. But to make each of these severally significant for thought would require a long series of successive acts of attention. Of course, the total impression which they collectively constitute may be significant, as in our first glance at a landscape before we begin to observe its component parts. The essential point is the antithesis

between the detailed determinateness of presentation and the comparative indeterminateness of discriminative thinking. The relative independence of presentation is perhaps even more strikingly illustrated by the sensations arising from our general bodily state. These appear to be constantly present in every moment of waking life—perhaps even in sleep. But as a rule they enter our trains of thought only in the vaguest way, if at all. Occasionally we say 'I feel well,' or 'I feel ill,' or 'I feel tired,' or 'I feel bright,' or 'I feel dull.' But for the most part we do not take any definite note of our condition. When we do so, we are always aware, if we reflect on the point, that the sensations which determine our judgment are not created by it, but are prior to it."*

Analytic Psychology, vol. i., pp. 48-49

CHAPTER II.

PRIMARY LAWS OF MENTAL PROCESS.

§ 1. *Relativity.*—"By the principle of relativity. . . .it is denied that any psychic factor, or complex psychosis,* can exist without having its own definite quality, quantity, tone of feeling, value in combination, and influence upon simultaneous or successive factors and psychoses, determined by the *relation* in which it stands to other factors and psychoses in the entire mental life. Or—stated positively—*every individual element, or state, or form of mental life is what it is only as relative to other elements, states, and forms of the same mental life.*"† More briefly we may say: *Mental development depends on modes of consciousness being determined by their psychological relations and subject to modification accordingly.* This statement, though sufficiently comprehensive, is proportionately vague. The vagueness lies mainly in the phrase "psychological relations." What is the nature of the psychological relations through which modes of consciousness are enabled to interact? To understand this we must consider the unity and continuity of consciousness. This topic falls under two heads, (1) general unity and continuity, and (2) the special unity and continuity constituted by conation.

* *Psychosis* = total state of consciousness as existing at any one moment.

† Ladd, *Psychology, Descriptive and Explanatory*, pp. 661-2.

§ 2. *General Unity and Continuity.*—The partial constituents of our conscious life are, as Dr. Ward puts it, not disjoined from one another by something which is disparate in nature from consciousness. They are not separated "as one island is separated from another by the intervening sea, or one note in a melody from the next by an interval of silence."* The unity and continuity of consciousness conceived in this most abstract and general form enables us to recognise what we may call relations of immediate contiguity. Whatever components of any given moment enter into the composition of a single state of consciousness are immediately contiguous. Similarly, successive states are in immediate contiguity if and so far as the termination of one coincides with the commencement of another. "At any given moment," says Dr. Ward, we have "a 'field of consciousness,' psychologically one and continuous; at the next, we have not an entirely new field but a partial change within this field."† Inasmuch as the emergence of the new is a modification of the old, they are continuous and so far psychologically contiguous. We have not merely A and then B, but also the passage of A into B; and this passage as such is a modification of consciousness. The transition is itself an experience. It is the more obviously so the more abrupt it is. The interruption, being a *felt* interruption, itself constitutes a relation between the two states, however unlike they may be. Take for instance an illustration given by Dr. Ward in another context—the "passing from the scent of a rose to the sound of a gong or a sting from a bee."‡ Professor Ladd well remarks, that in "the case of so abrupt a transition in the content and

* Article "Psychology," in the *Encyclopaedia Britannica*, 9th edition, part xx., p. 45.

† *Ibid.* ‡ *Op. cit.*, p. 50.

feeling-tone of two successive mental states, the law of relativity would not be violated, but the more amply illustrated. The amount of our absorption in the scent of the rose would influence the redistribution of attention to the sound of the gong, and even to the sting of the bee; the degree of pain which the succeeding sensations of sounds or smarting gave would be enhanced by the preceding pleasure; the control of the motor results of [movements prompted by] the new sensation would be determined by the perceptions, etc., into which the sensation abruptly broke; and so on, and so on."*

Thus there are relations arising out of the unity of a single state of consciousness as it exists at any moment, and there are also relations arising out of the transition from one state to another. These relations involve immediate contiguity in time; either in the way of simultaneous existence or of continuous succession. But there is another kind of psychical connexion independent of direct proximity in time, and arising out of a more special and intimate continuity than that which is characteristic of the flow of consciousness in general.

§ **3.** *Conative Unity and Continuity.*—Suppose that, while playing chess or whist, I am suddenly called away at a critical stage of the game to meet a visitor on a matter of business. The interruption, as such, constitutes a relation between the state of consciousness which is interrupted and that which interrupts it. But this relation exists between otherwise disparate and disconnected processes, and depends on that immediate contiguity in time which has been discussed. If, on the contrary, we consider the successive phases of the process of making up the mind about the move at chess, or of settling the matter

* *Psychology, Descriptive and Explanatory*, p. 663.

of business, we find a different and more intimate kind of continuity, which may be called conative or appetitive continuity, or continuity of interest. From this point of view, my state of mind when I have finished my business with the visitor and returned to my game is continuous with my state of mind when I was interrupted, rather than with the intervening flow of consciousness. The very word interruption implies this. It is clear, then, that continuity of interest is more or less independent of direct proximity in time. This kind of continuity is essentially connected with mental activity in the strict sense, with the striving, conative, appetitive side of our nature. Its general condition is that the successive phases of a conscious process shall constitute a movement towards an end. By an *end* is meant a state of consciousness in which the process finds its natural termination—the termination prescribed to it by its own nature, and not by extraneous conditions. Each phase of the process before the end is reached is incomplete, and tends by its own inherent constitution to pass beyond itself. If the activity is displaced by a disparate and disconnected process before it has attained its goal, it tends spontaneously to recur after the interruption and work itself out, starting from the stage at which it was cut short. If, while it continues to occupy consciousness, its progress is in any way checked or arrested, an experience of dissatisfaction or unpleasantness arises. So long and so far as its progress is unchecked, but not yet completed, consciousness is unsatisfied, but not dissatisfied, and *ceteris paribus* the experience is pleasant.

Conative unity depends upon conative continuity. If we take any momentary phase in the flow of conative process, we find a total state of consciousness in which some constituents are irrelevant to the main direction of thought,

and others are essentially concerned in its progress. Thus in playing a game of chess the modifications of consciousness due to impressions from surrounding objects are irrelevant to the main current of consciousness. Only the experiences connected with the position of the pieces on the board are relevant, and only these experiences are embraced in the conative unity of consciousness. This distinction corresponds broadly to that between thought and mere sentience.*

The total process of consciousness is, in general, composed of a succession of processes, each of which has a certain appetitive continuity. Some of these may be very transient and involve only a slight and evanescent interest. But in so far as they involve interest or attention at all they are essentially conative. Even when the mind rambles from object to object in a desultory way, its slight and transient occupation with each in turn involves some degree of attention and interest. Thus the transitions which are without conative continuity are transitions from one conative process to another. But even these are in a sense conative, if one process occurs as a marked interruption of another. In the moment of interruption, the interruption itself constitutes a sort of conative continuity between the old process and the new. Just in so far as the new process is experienced as an interruption of the old, it is a constituent part of it, an incident in its progress.

In the development of the mental life, conative unity and continuity is of altogether predominant importance. Such psychical relations as depend on mere proximity in time are subsidiary, and may, in a broad view of mental evolution, be neglected. Thus, in what follows, we shall almost entirely confine our attention to those mental

* Discussed in § 5 of last chapter.

connexions which arise from the combination of mental elements as constituent parts of the same conative process.

§ **4**. *Retentiveness.*—Retentiveness in some form is an indispensable condition of development or progress of any kind. Advance would be impossible unless the results of prior process persisted as the basis and starting-point of subsequent process. In marching, each step has its point of departure from the new position secured by the previous step. In marking time there is continual reversion to the same position and no advance. No house could be built if each brick vanished as it was laid and had to be replaced anew. A rope cannot be formed of dry sand, which crumbles away as it is put together. Similarly, mental development would be impossible unless previous experience left behind it persistent after-effects to determine the nature and course of subsequent experience. These after-effects are called, in psychology, *traces* or *dispositions*, and the psychological law of retentiveness may be stated as follows: *when and so far as mental development takes place through mental conditions, it does so because specific modes of consciousness leave behind them specific traces or dispositions, which determine the nature and course of subsequent process, so that when they are modified it is modified.*

The persistence of dispositions is not absolute; they tend to decay, and may perhaps disappear altogether if they are not maintained by renewal of the corresponding mental processes, or of mental processes connected with these. In this respect there is a great difference between different individuals. Some are more retentive than others. But even in the most retentive minds, traces tend to fade away: "so that if they be not sometimes renewed by repeated exercise of the senses, or reflection on those kinds of objects which at first occasioned them, the print

wears out, and at last there remains nothing to be seen." Thus the experiences, "as well as children, of our youth, often die before us; and our minds represent to us those tombs to which we are fast approaching, where, though the brass and marble remain, yet the inscriptions are effaced by time, and the imagery moulders away."* The differences in the retentive power of individuals are, in part at least, differences in original endowment, and cannot be explained on psychological grounds. As Locke remarks, some minds retain the characters drawn on them "like marble," others "like freestone," and others "little better than sand." The ultimate explanation of this difference in original endowment must take a physiological form.

§ 5. *Conative Continuity and Retentiveness.*—The kind of continuity which we have called conative involves in a characteristic way the principle of retentiveness. All progress towards an end depends on the persistence of the results of previous process as the basis of succeeding change. So in this case, continuity of interest is only possible if and so far as each succeeding stage of the movement of consciousness towards an end is determined and qualified by the cumulative disposition left behind by preceding stages. At the same time this cumulative disposition is itself subject to modification by each new mode of consciousness as it emerges. Dr. Ward has given an example which partially illustrates this point.

"Suppose that in the course of a few minutes we take half a dozen glances at a strange and curious flower. We have not as many complex presentations which we might symbolise as F_1, F_2, F_3. But rather, at first, only the general outline is noted, next the disposition of petals,

* Locke, *Essay Concerning Human Understanding*, ii. x., 5.

stamen, etc., then the attachment of the anthers, form of the ovary, and so on. . . . . It is because the earlier apprehensions persist that the later are an advance upon them and an addition to them."*

This example excellently illustrates the working of retentiveness where there is continuity of interest. But it does so only partially and for a special case. The case adduced is one in which "earlier apprehensions" recur as part of the same simultaneous whole with the later. The process by which the "earlier apprehensions" were originally formed is not itself repeated, inasmuch as the preparatory dispositions left behind by previous experience render it unnecessary. Hence, there is room for further advance,—for growing distinction and definition within the total presentation But with the new distinctions the old also are combined in the same complex whole. This is one of the ways in which preformed dispositions may operate. But it is by no means the only way. The persistent traces of past experience may modify present experience and be modified by it, without reappearance of the content of the past experience in the actual moment of present consciousness.

The effect of rhythmic repetition of the same stimulus is peculiarly instructive, because the external occasion of each successive impression is throughout the same, so that modifications of consciousness arising in the course of the process must be due to the working of retentiveness,—to the cumulative disposition left behind by previous impressions. The sequence of physical stimuli is $a, a, a, \ldots$. the sequence of mental states is $a_1, a_2, a_3, \ldots$. The mere fact that the second a comes before consciousness as a *repetition*, as *another* of the same kind, constitutes an

* Article "Psychology," p. 47.

important difference between it and the first *a*. But, besides this, there may be a gradual modification of consciousness as the series advances, until a point is reached in which each new impression produces an effect relatively so small, in comparison with the accumulated result of previous impressions, as to be inappreciable. This is well brought out in certain experiments on what is called the "span of consciousness." The purpose of these experiments is to ascertain how many objects of a certain kind can be apprehended at once. It is found that, after hearing as many as fifteen or sixteen successive sounds at regular intervals of from 0·2 to 0·3 seconds, the subject can identify or distinguish this series as a whole from another equal or unequal to it. Counting is not admitted, and the successive sounds are of course not all simultaneously discriminated at the close of the series. A "sensation-mass" alone is distinctly perceived. This is evidently a cumulative effect. Apart from special experiments in the laboratory, anyone can easily verify the statement that successive series of a rhythmic character can at their close be apprehended as a whole without mentally reproducing and discriminating in the moment of apprehension the several sequent parts which compose them. Thus, in walking, we may mentally divide our successive steps into distinct groups, and be aware without counting when one series ends and another begins. We need not even know the number of steps which are mentally connected within a single series. We may simply begin by walking a certain number of paces without counting them, and then as we proceed mark the points at which the initial series has repeated itself.

We have so far considered only the regular sequence of physically identical impressions. But the most important

cases of rhythm are those in which recurrent similarity in certain respects is combined with diversity in other respects. The rhythm of verse, which depends on a more or less uniform recurrence of long and short or of accented and unaccented syllables, may serve as an illustration. In hearing a line from Milton or Vergil we need not at any moment have more than one word actually present to consciousness. Yet this single word appears as part of the whole and is qualified in a quite specific way by its place in the whole. The sound of the word "unpremeditated" has a quite different value for consciousness in the present sentence or in a dictionary from that which it acquires in Shelley's lines:

> "That from heaven, or near it.
> Pourest thy full heart
> In profuse strains of unpremeditated art."

Substitute "unstudied" for "unpremeditated," and the result is not merely one word in place of another. On the contrary, the occurrence of the wrong word is for consciousness the ruin of the whole rhythmic structure. What is true of verse is still more obviously true in the case of music. The last note of a melody may be and often is the only note of which we are aware at the moment it strikes the ear. Yet in it the entire melody is in a sense present. It comes before consciousness as part of a quite specific whole and derives a specific character from its place in that whole. The cumulative disposition generated by the ordered sequence of previous notes cooperates with the new stimulus to the organ of hearing, and the ensuing state of consciousness is the joint product of both factors mutually modifying each other. If a wrong note be struck, the whole melody is at once marred. The same happens if a note is unduly prolonged. Throughout the process the part is

determined by the whole, and the whole by the part. In reading a sentence or a paragraph, when we come to the final word, the meaning of the sentence or paragraph as a whole is present to our consciousness. But it is only as a cumulative effect of previous process. What is directly given as a special datum is the last word itself and its meaning. In a similar way, the cumulative effect of one paragraph or chapter of a book qualifies and determines the meaning of another. We may set by the side of this highly complex case a very simple one. Pronounce successively the words *fructify*, *mystify*, *identify*, *simplify* ; all these words terminate in the same sound. When we are just finishing or have just finished the utterance of each word, the special item of sensation before consciousness is the final sound they have in common. The preceding sounds in which they differ have vanished from consciousness; nevertheless, in each case we are aware that we have said one word and not another, that we have said *fructify* and not *mystify*, and so on. This can only be because in each instance our consciousness, when the final sound is being pronounced, is modified by the cumulative effect of the preceding sounds.

This cumulative effect of the preceding phases of a conative process on the succeeding, may be called *primary* retentiveness, in order to distinguish it from the retentiveness which is involved in reproduction and association,—processes to be discussed later on.

§ **6**. *Primary meaning.*—Primary retentiveness is correlated with what we may call primary meaning. We may sum up the result of the last section as follows: (1) In all processes having appetitive or conative continuity, and consisting of a series of distinct steps, a cumulative disposition is gradually formed which is the product of

antecedent mental change, and a cooperative factor in succeeding mental change. (2) The after-effect of preceding mental process is not reproduced, but simply persists or is retained. (3) Its persistence in no way involves the persistence or the resuscitation of the specific items of sensation or mental imagery which have contributed to form it. These do not persist, but only their effects. If we denote the sequences of specific items of sense-experience, or, it may be, of ideal imagery, by *a*, *b*, *c*, *d*, then *a*, *b*, *c*, *d*, by no means adequately symbolises the process as a whole. For when *b* occurs, the resulting state of consciousness is the joint product of *b* and the persistent disposition or after-effect left behind by *a*. Similarly, when *d* occurs, the resulting state of consciousness is due to *d* in cooperation with the persistent disposition left behind by *a*, *b*, and *c*. We may denote the after-effect of *a* by m_1, the after-effect of *a* and *b* by m_2, and so on. The whole series may then be represented by *a*, bm_1, cm_2, dm_3.

Now what does *m* stand for? What change or modification of consciousness does it represent? Clearly, it represents the relation of the specific items *b*, *c*, *d*, to the whole of which they are part, a peculiar character which belongs to them in virtue of their being part of this whole. Now the only general word which is at all appropriate for expressing this kind of consciousness is the word *meaning* or *significance*; *m*, then, stands for meaning or significance. The meaning which is essentially involved in all conative continuity may be designated *primary* meaning, to distinguish it from that which depends on association and reproduction.

§ 7. *Association and Reproduction.*—On seeing a flower, I am told that it has a certain name. Afterwards, I hear

this name again: it may then call up to my mind a mental picture of the flower, though no flower is actually present. It is clear that if I had never seen the flower, the mental picture of the flower would not have arisen. Now suppose the original perception of the flower had left no trace behind it after itself ceasing to exist,—that it had flitted over the surface of my mind like a shadow over the surface of a stream, without producing any permanent result. The case would then have been just the same as if I had never seen the flower. The mere hearing of the name would be inoperative unless there were something for it to act on,—an appropriate *trace* of past experience constituting a preparatory *disposition* for future experience. But primary retentiveness is not in this case sufficient. More is implied than the mere cumulative effect of the previous phases of a continuous process determining succeeding phases. Retentiveness in this instance works by way of reproduction and association. The specific nature of the original experience which we call the perception of the flower, is partially reinstated in the mental image of the flower. The name, as we say, *reproduces* the mental image. It does this through association. The actual perception of the flower occurred as part of the same continuous conscious process as the hearing of the name. Hence, when the name occurs again, it may re-excite the mental disposition left behind by the perception, and re-excite it in such a way that the mental image of the flower rises before the mind although no actual flower is present to the senses. In so far as the mere fact that a certain modification of consciousness has already occurred constitutes the general possibility of its recurrence, retentiveness takes the form of reproduction. The general possibility of recurrence is for the most part actualised in

each special case by association. The disposition left behind by the previous experience must be re-excited if the experience itself is to be reproduced. The re-excitement is mostly, though not always, effected by a presentation similar to some presentation which has formed part of the same total process with the experience which is to be reproduced. This is expressed by saying that the re-instatement takes place by the previous association of the reproduced and reproducing presentation. In the example given, the association is between the perception of the flower and its name. The repetition of the name revives the mental image of the absent flower.

§ 8. *Acquirement of Meaning.*—Reproduction has a great many modes and degrees, according as the original experience is more or less fully and independently re-instated. The least that can happen, in order to make the word *reproduction* applicable at all, is found in a process of fundamental importance which we may call the *acquirement of meaning*. We must distinguish between meaning which is primary and meaning which is acquired. Primary meaning accompanies the first occurrence of any series having continuity of interest. Secondary meaning accompanies its recurrence, and depends on the fact that it has occurred before. In the series a, bm_1, cm_2, dm_3, on its first occurrence d has a meaning due to the cumulative disposition left behind by a, b, c. Now, suppose that on a future occasion the process as a whole is repeated. Its point of departure is in a, but a now excites the cumulative disposition produced by the previous occurrence of the whole series a, bm_1, cm_2, dm_3. The starting-point of the series is therefore no longer a, but am_3. In other words, a has *acquired meaning* through previous experience. Let us consider the example of a

tune. On first hearing it, the successive notes have each a significance,—a value for consciousness derived from their connexion with the whole. Now suppose that the tune has been repeated often enough to become recognisable. In order to recognise it, it is not necessary to go through the whole again. You know what the tune is as soon as you have heard a certain portion of it. This stands for or *means* the rest; and if you are only interested in recognising the tune, it is quite unnecessary to go further, or even mentally to reproduce what follows. So, if I begin to say, "Twice one is two, twice two"—there is no need for me to go further. A hearer who knows the multiplication table knows what follows as a whole without detailed repetition. The beginning of the series is equivalent to the whole, and it is just because it *means* the whole that it is unnecessary to repeat the whole in detail.

Let us now take a case which belongs to quite a low level of conscious life. A chick on emerging from the shell, and without previous experience, tends to peck at, seize, and swallow all small objects*. This is a conative process, which has for its end the cessation of the appetite for food. Now the chicken does not, at first, distinguish between what is edible and what is not. This it has to learn by experience. It will at the outset peck at and seize all worms and caterpillars indiscriminately. There is a particular kind of caterpillar called the cinnabar caterpillar. When this is first presented to the chicken it is pecked at and seized like other similar objects. But as soon as it is fairly seized it is dropped in disgust. When next the chicken sees the caterpillar, it looks at it suspiciously and refrains

* This example is taken from Lloyd Morgan's *Habit and Instinct*, p. 41.

from pecking. Now, what has happened in this case? The sight of the cinnabar caterpillar re-excites the total disposition left behind by the previous experience of pecking at it, seizing it, and ejecting it in disgust. Thus the effect of these experiences is revived. The sight of the cinnabar caterpillar has acquired a *meaning*. It means the experiences which in the first instance followed it; and just because it means them it may more or less dispense with the necessity of actually repeating them. It may so determine the course of action that repetition or re-instatement of the specific items of the previous experience is needless. To this extent, it is practically equivalent to them: it functions instead of them.

When one thing *means* another, it can, for certain purposes, or in reference to a certain end, be substituted for another. If *a* means *b*, this does not imply that *a* carries *b* along with it or about with it. We might as well suppose that a five-pound note must always have five sovereigns literally wrapped up in it. The note will pass current instead of five sovereigns, and in like manner the peculiar visual appearance of the cinnabar caterpillar will, in some degree, pass current instead of the peculiar sensation of disgust which has previously followed it. It re-excites the whole disposition left behind by the previous process, and it re-excites this disposition as it has been modified in the course of previous process. Consequently, this process will not take place again as it took place before. But to understand the special kind of transformation which it undergoes, we must take into account the essential nature of appetitive process. This lies in its being directed to an end,—in the case of the chicken, the satisfaction of the appetite for food. This tendency towards an end is manifested in one general character of all appetitive process. Lines of action, if and

so far as they are unsuccessful, tend to be discontinued or varied; and those which prove successful, to be maintained. In this way, for instance, accuracy in the act of pecking is attained by the chicken. When it misses, it tries again and again with slight variations until it succeeds, and it is the successful adjustments which tend to persist, and the unsuccessful which are eliminated. The endeavour towards an end, whether the end be consciously foreseen or not, is *ipso facto* an endeavour to avoid failure and obstruction. Everything in the way of check or impediment or want of success, causes dissatisfaction and altered behaviour. This holds good of appetitive activity in its primary occurrence; it is always characterised by persistence with varied effort. The same must also hold good for its repetition. Here, too, the lines of action which proved unsuccessful on its primary occurrence will be suppressed whenever the conditions under which they previously led to failure are recognisable. Thus, the sight of the peculiar markings of the cinnabar caterpillar will, at the outset, by its acquired meaning, repress the tendency to peck and swallow. In other words, so far as the end of action is concerned, the sight of the caterpillar is superior to the actual taste of it, just as cheques and paper money generally are for certain purposes superior to coin.

The process which we have called the acquirement of meaning is the minimum in the way of reproduction required to explain intelligent learning by experience. All more specific modes of reproduction pre-suppose it, and owe their guiding efficacy to it. All revival of specific items of sensation and the like, in so far as it makes possible intelligent adaptation to the result of previous experience, must make more definite and explicit the peculiar consciousness which arises from the re-excitement

of the total disposition left behind by previous process. The case we have analysed is sometimes explained in a different way. It is said that when the chick sees again the caterpillar, which it has previously ejected in disgust, the previous sensation of disgust is reproduced by the sight of the peculiar markings of the caterpillar. The primary experience of disgust prompted the ejection of the caterpillar; hence, it is argued, the revived sensation will lead the chicken to refuse the unsavoury morsel. Now, it is probable enough that something which may be called a revival of the disgusting sensation, actually takes place; but this is not sufficient, and possibly not necessary, to account for the result. According to the proposed explanation, the chick has (1) a primary sense experience, the sight of the caterpillar, and (2) a faintly revived sensation of disgust. What must follow? Each of the two sensations, the one primary, and the other secondary, independently prompt to a certain kind of action, and the result can only be a sort of mechanical interference, not intelligent guidance. The visual experience prompts to picking and seizing. The revived distaste prompts to the act of ejecting or dropping from the beak. The tendency to ejection ought to interfere with the act of pecking only in so far as the two movements are mechanically incompatible. One would expect a nondescript blend of the two movements, or an alternation between them. Intelligent behaviour cannot be a product of such conditions. Two motor impulses of a quasi-reflex character are brought together in a mechanical way, and nothing can ensue except a sort of mechanical resultant. It is true that if it be granted that the sight of the cinnabar caterpillar has, from the first, a specific meaning, this meaning may be rendered more explicit by re-instatement of the sensation of disgust. But the mere re-instatement

of the sensation of disgust taken by itself does not account for the result, whereas the acquirement of meaning might account for the result apart from the revival of the specific sensation. In the case we are discussing, there probably is a certain revival of sensation, though it takes place in a peculiar way, and not by direct association.*

Acquirement of meaning is that mode of reproduction which approaches most nearly in its nature to primary retentiveness. It might indeed be deduced *à priori* from the existence of primary retentiveness. If the successive phases of a process concur to form a total disposition as their cumulative effect, the renewal of a part of the process must tend to re-excite this disposition. Just as in primary retentiveness it is not the specific items of previous experience which persist in succeeding experience, but only a modification of consciousness due to the cumulative disposition, so the re-excitement of the cumulative disposition does not necessarily involve revival of the specific items of previous experience, and it must involve something different from this. It must involve what primary retentiveness involves,—that peculiar modification of consciousness which we can only call *apprehension of meaning* or *significance*—of the peculiar character which the part derives from its relation to the whole.

We have now to consider modes of reproduction more specific in their nature than the general re-excitement of a total disposition. These more specific modes of reproduction assume manifold forms and gradations, which are to be regarded as stages in the evolution of meaning towards definiteness and explicitness. Meaning unfolds into them as the seed unfolds into the plant.

* *Cf.* end of

§ 9. *The various modes of Specific Reproduction.* (*a*) *Complication.*—Being reproduced is something different from being produced again. Repeated production involves a renewal of the producing conditions. But reproduction exists only in so far as the original conditions of production are inoperative (see § 7). Apart from the renewal of these, the previous occurrence of the reproduced experience of itself constitutes the possibility of recurrence. This necessarily implies that the previous occurrence has left behind a persistent trace or disposition. But previous occurrence constitutes only the general possibility of recurrence. The exciting cause, in so far as the revival depends on association,* is found in the occurrence of another presentation, *A*, which has previously existed in some kind of *psychological relation* to *B*, the presentation which is reproduced. In the main, the relations which operate as conditions of association consist in the union of the two modes of consciousness, as parts or phases of the same continuous conative process. The readiness with which associations are formed, and their strength, depend largely on the importance of the presentations in relation to the whole activity of which they form a part. The strength of the association is also, to a very great extent, dependent on the number of times the connexion between the associated presentations has been repeated.

Specific reproduction may assume a great variety of forms and degrees. Let us call the reproducing presentation, *A*, and that with which it has been associated, *B*: the reproduced presentation may be denoted by *b*. Now, the various forms of reproductive process depend (1) on the varying relation of *b* to *A*, (2) on the varying degrees of completeness in which *b* corresponds to *B*. These points

* This is by no means always the case.

of view are intimately connected. *b* may be either an integral part of *A*, or it may have a distinct individuality, so as to be capable of persisting when *A* has vanished. In the second case, the process is one of free reproduction: when *b* is an integral part of *A* and incapable of independent existence, the process is called *complication*, because the result is merely a change in the constitution of *A*, and for the most part an increase in its complexity. The facility and clearness with which *b* can be distinguished and separately attended to in the whole complex *A* admits of many gradations. It may be as intimately interfused with the whole as the red and blue which interpenetrate each other in purple. On the other hand it may be as easily disengaged as colour is from form. In general, the more intimate is the union of *b* with the other constituent characters of *A*, the more partial and the more profoundly modified is the reproduction of *B*, so that in some cases it is hard to decide whether or not there is any reproduction.

We may take as a typical example of complication the peculiar differences of quality which attach to sounds according to the various modes in which they are produced. We distinguish clapping, crashing, clashing, hissing, bursting, splitting, rending, grinding, rushing, and whistling noises. Now these sounds doubtless have distinctive qualities, considered merely as auditory sensations. But it seems clear that they also have acquired modalities due to association. In producing them we have in each case certain distinctive experiences of movement and resistance, and in seeing them produced similar experiences are excited in a partial and inchoate way. When the sounds are merely heard their quality is partly constituted by a partial and modified reproduction of these sensations. The reproduced element is not usually distinguished without an

express act of analytic attention. But it is none the less present as a peculiar modality of the auditory experience. Perhaps this will be most clearly brought out by considering the imitative words by which the nature of such sounds is commonly expressed. The word "clap" resembles the sound of clapping, the word "hiss" the sound of hissing, and the word "tear" the sound of tearing. But on examination it soon appears that the resemblance by no means lies wholly in the sounds considered merely as ear-sensations. It depends also on the movements of articulation. In saying "clap," the lips are clapped together; in saying "hiss," the breath is driven through a narrowed aperture; in saying "tear," the tongue is pulled away from the palate. In these and similar instances we do not ordinarily distinguish between the motor and the purely auditory imitation. So in the original experiences which are imitated the two factors are combined without distinction, constituting a complex sensory quality which escapes analysis until the reflective scrutiny of the psychologist is brought to bear upon it. In this complex quality the sound as such is the dominant constituent, and the associated motor element appears as a modification of the sound.

For further illustration we may refer (1) to the qualification of sight by touch and resistance, and (2) to the qualification of touch and resistance by sight.

"The sight of a suit of polished armour," says Dr. Ward, "instantly reinstates and steadily maintains all that we retain of former sensations of its hardness and smoothness and coldness*." The armour *looks* hard, smooth, and cold. But this peculiar appearance to the eye does not necessarily

* Article "Psychology," *Encyclopaedia Britannica*, 9th edition, part xx., p. 57.

involve any distinct representation or idea or separate sensation of hardness, smoothness, or coldness. The corresponding tactile and other experiences are not reproduced as separate and distinct modes of consciousness. They are not discriminated from the visual experience itself. The reproduction manifests itself rather as a modification of the visual experience—an addition to its unanalysed complexity. Similarly, ice looks cold because we have felt it to be cold. If it had been always warm to the touch, it would have looked warm. Yet its cold look is not a suggested idea; nor is it a distinct temperature-sensation. It is something which is presented as if included in the visual appearance as an integral part of it. Any attempt to separate it destroys both its own specific character and that of the visual experience.

If (2) we now turn to the converse case, the qualification of actual touch experience by revived visual experience, we find the union of the constituents of the complex much looser. This does not mean that they are more easily separable; for the association in normal human experience is almost, if not quite, indissoluble. But when the tactual experience is primary, the reinstated visual experience is much more prominent, more readily distinguishable and separately appreciable, than is the reproduced tactual element when the visual experience is primary. We have here a case of complication which approaches most closely to free reproduction. When we close our eyes and touch an object, we need not indeed have a distinct picture of the surface touched. But the slightest reflective scrutiny is enough to show that the total impression is complex, containing a visual as well as a tactual constituent, and also, in most cases, that the visual constituent is as prominent as the tactual or even more so.

(*b*) *Free Reproduction.*—In free reproduction, the reproduced mode of consciousness, *b*, is capable of existing apart from the *A* which reinstates it. *b* has an individuality of its own distinct from *A*, and it can therefore follow *A* in time, continuing to exist when *A* has disappeared. Trains of ideas supply by far the most familiar and important illustration. In complication, on the other hand, the existence of *b* is bound up with the existence of *A*. "To realise this difference," says Dr. Ward, "we need only to observe first how the sight of a suit of polished armour, for example, instantly reinstates and steadily maintains all that we retain of former sensations of its hardness and smoothness and coldness, and then to observe how this same sight gradually calls up ideas, now of tournaments, now of crusades, and so through all the changing imagery of romance."* The characteristics of ideas and the nature of their distinction from actual perceptions are topics which will be fully discussed at a later stage. It is sufficient to notice here (1) that any reproduction which can be called an idea, must have sufficient independence to be capable of forming a distinct link in a train of thought; (2) that it must be the thought of an object, such as a thing, quality, relation, or event, and not a mere crude sensation, however faint; (3) that just because an idea differs from an actual perception, ideal reproduction† is always of a partial and modified character. The mental image of the flower, as called up by the name, is a typical illustration (*cf.*, § 7).

Is free revival in every case ideal revival, or does it also take other forms? In particular, are sensations, as such, ever re-instated? Can they be recalled in their original sensational character without recurrence of the appropriate

* *Ibid.* † Reproduction which takes the form of an idea.

external stimulus? This is an important question. Broadly speaking, we may affirm that the *direct* reproduction of sensations, as such,* is an exceptional and abnormal event. But there is an indirect process by which sensations of a certain class may be re-excited, although some of the conditions determining their first occurrence are by no means operative. Some sensations belong to the class called organic. It is characteristic of these that they are immediately excited, not by impressions upon the external organs of sense, but by the changing states of the internal organs, such as muscles, glands, and the like. Now, change in the state of these internal organs is, in a very important measure, determined from within the body by changing conditions of the nervous system. Any strong nervous disturbance tends to discharge itself over the whole organism, affecting respiration, heartbeat, tension of the muscles, circulation of the blood, secretion, etc. Such a nervous disturbance may, in the first instance, be set up by an external impression such as a wound or a blow. But it may be afterwards more or less reproduced by association without the external impression, and it may then internally generate organic sensations bearing a marked similarity to those which accompanied its original occurrence. These sensations may without impropriety be said to be *reproduced*, though in a circuitous manner. The physiological stimulus is indirectly re-instated, and it directly produces the sensation. Tickling is not merely a skin-sensation. The skin-sensation sets up changes in the central nervous system which determine diffused organic disturbance, including spasmodic movements, and the resulting organic sensation constitutes what

* By *sensation, as such*, is meant sensation with the peculiar intensity and liveliness which it possesses when produced by an external stimulus acting on a sense-organ.

is most specific in the experience of being tickled. But a similar effect may be induced without actual contact. By merely making believe to tickle a sensitive person it is possible to produce the nervous disturbance with the resulting organic sensations and convulsive movements. In like manner, the mere sight of nauseous food may produce nausea and even vomiting. The intense organic discomfort which may be occasioned by merely looking on at a surgical operation, or even by seeing surgical instruments, has the same origin.

§ 10. *Facilitation and Arrest.*—In actual reproduction, one mental process reinstates another. But instead of actual re-instatement, we may have mere *facilitation*. The one mental process may favour the entrance of the other into consciousness, without actually introducing it into consciousness.

Facilitation may assume many forms and take place under many diverse conditions. It is an essential characteristic of attention. The nurse whose attention is concentrated on the sick child is pre-disposed to notice whatever sign or movement it makes, and to take action accordingly. Her mind is set in a general attitude of response to whatever impressions come to her from this source. This general attitude of response to a certain kind of stimulus may persist even when conscious attention has itself ceased. The nurse who goes to sleep with her attention concentrated on the child is likely to be awakened by the slightest cry from it, though more intense sounds fail to disturb her repose.

Under the head of facilitation due to attention we may bring a fact noticed by Mr. Verdon in a very interesting paper on "Forgetfulness."* "Individuals often remember

* *Mind*, O.S. ii., 149.

clearly and well up to the time when they have to use their knowledge, and then, when it is no longer required, there follows a rapid and extensive decay of the traces. Many schoolboys forget their lessons after they have said them; many barristers forget details got up for a particular case. Thus, a boy learns thirty lines of Homer, says them perfectly, and then forgets them so that he could not say five consecutive lines the next morning, and a barrister may be one week learned in the mysteries of making cog-wheels, but in the next he may be well acquainted with the anatomy of the ribs instead." In other words, the general direction of interest facilitates the recall of certain experiences. It makes the corresponding dispositions more readily excitable. This seems only partially to depend on direct attention to the special subject-matter to be remembered. The barrister who keeps in mind for a week "the mysteries of making cog-wheels" does so through general interest in the case which he has in hand, and not by constantly thinking of cog-wheels. In other words, the corresponding mental dispositions are maintained in an excitable condition, not so much by attending directly to the subject matter, as by attending to something connected with it. So long as the need for remembering remains, there is a sense of having something on the mind. When the need no longer exists, a feeling of relief is experienced, and the power of remembering disappears.

If we learn something by heart, *e.g.*, a page of verse, we may afterwards so far forget it as to be unable to recall the words in their proper order. We may then set about learning it anew. But on the second occasion it may take very much less time to do so than on the first. The original learning by heart has *facilitated* the second.

The nature of facilitation is well illustrated in a series of experiments carried out by Professor Pillsbury.* Printed words variously mis-spelt were successively exposed on a screen for a period of about one-fifth of a second. The subject of the experiment was called on to read off these words. He did so for the most part incorrectly, and most often without noticing the wrong spelling. We have here nothing to do with the nature and frequency of the mistakes. What does interest us is the effect produced by calling out a word having some association with the word to be shown immediately before the exposure was made. The result of this was always a great increase in the number of mis-spellings overlooked. "In only a very few cases did the word called out suggest the word to be shown before the latter was seen, and then the misprints were observed quite as frequently as at other times. In most cases, the relation between the two words was noted after the printed word was seen. In such cases, the association helped the entrance of the word. It seemed to confirm the results of the visual impression, and to give a feeling of confidence that the word seen was the word intended." The words called, though they did not of themselves actually reproduce other words, yet facilitated the perception of one word rather than of another.

Arrest may be regarded as the negative side of facilitation. Whatever facilitates the occurrence of certain mental processes is a bar to the occurrence of others. The nurse, with attention concentrated on the child, is apt to overlook impressions which are not connected with the main direction of her interest. In general, any mental process tends to hinder the occurrence of others, if and so far as it does not facilitate their occurrence.

* "A Study in Apperception." *American Journal of Psychology*, viii. 3.

§ 11. *Habit and Automatism.*—Actions at first requiring attention come to be performed without attention when they are frequently repeated under sufficiently similar conditions. In such instances, the action is said to be *automatic*, to go on of itself. "The clearest examples of habitual action taking place apart from attention are those in which attention is otherwise occupied, as when a person knits, or plays on a musical instrument, and at the same time engages in conversation, or threads his way through a crowded street while absorbed in thought. It should be noted that in such instances the diversion of attention is probably never absolutely complete. The musician, for instance, is more or less aware that he is playing a piece of music, and the absent-minded walker is not utterly oblivious of the fact that he is in a crowded street and in motion. What can be asserted confidently is that in such cases there is no persistent and discriminating attention to the details of the action. This distinction helps us to understand another group of habitual actions which do not appear to fall into the state of secondary automatism, however much they may be practised. Fencing supplies a good instance in point. The most expert fencer cannot afford to allow himself to be absorbed in an irrelevant train of thought while he is engaged in a duel. On the contrary, the keenest watchfulness is required. The reason is that only certain component parts of the action have become thoroughly habitual; these do not of themselves require to be attended to. The practised fencer has not to think about the proper modes of thrusting and parrying; what requires attention is the tactics of his opponent. As soon as he discerns by sight or feeling the direction in which his antagonist's rapier is moving, the proper reply is made automatically. Thus, attention is

demanded for the proper combination of a series of movements which are severally automatic, a combination which has to be adjusted to constantly fluctuating conditions. The union of attentive adaptation to relatively novel circumstances with automatic adaptation to circumstances more uniformly repeated is found in all ordinary voluntary action. Thus, the decision to blow out a candle may require attention, but the process of walking towards it and blowing is automatic."*

Habit is not confined to bodily actions. There are also habits of thought and of will. Of course, thought and volition are in their very nature processes that involve attention. When we speak of a "habit of thought" or a "habit of will," we do not mean that the special acts of volition or the special trains of thought can go on without attention. We have seen that in such bodily activities as fencing, "automatic processes may enter as component parts into a total process which as a whole is very far from being automatic. The inverse of this is seen in habits of thinking and willing. Here a comprehensive habitual tendency realises itself on special occasions by means of special processes which are not habitual."† We may take as an example the habit of answering letters on the day on which they are received. Here, what is habitual and automatic is not the actual process of writing the reply—this, of course, requires attention—but the writing of the reply on the same day on which the letter is received is a habitual and automatic procedure. It takes place as a matter of course. The alternative of postponing it to another day is not entertained without exceptional motives. A good instance of a habit of thought is that of the making of puns. There are some persons who continually

* *Analytic Psychology*, vol. i., pp. 260-261. † *Ibid.*, p. 262.

make puns simply because they have fallen into the habit of doing so. Of course each single pun requires attention; but the general trend of attention in this direction rather than in other directions is a matter of habit.

The formation of habit involves the operation of two distinct conditions. The first is retentiveness; the second lies in the essential nature of conation, according to which conative processes cease, if and so far as their end is attained. Let us take as an example the child learning to walk. This at the outset involves full attention. "At the outset, performance falls far short of intention: only a certain series of contractions of certain muscles, in proper proportions and in a proper order, is capable of realising the end aimed at, with the maximum of rapidity and certainty, and the minimum of obstruction and failure, and corresponding effort. At the outset of the process of acquisition, muscles are contracted which are superfluous, and which therefore operate as disturbing conditions. Others are not contracted at the right moment, and in the right measure, so that action is deranged. Now the effort to attain the end is, *eo ipso*, an effort to avoid failure and obstruction; hence there will be a constant tendency to alter muscular adjustments in so far as they are unsuccessful. Hence arise gradual approximations to success, and it is these which are permanently retained, while all that belongs to the process of trial, as such, disappears. In this way a fixed and uniform series of movements is organised, which can go on of itself without conscious effort,—without trial and failure.*

It will be seen that the formation of habit is an example of facilitation. The dispositions left behind by previous conation facilitate subsequent conation in the attainment

Op. cit., pp. 267-268.

of its end. When this process of facilitation reaches a point at which conscious endeavour is no longer necessary, the action becomes automatic.

§ 12. *Physiological Dispositions.*—In using such words as *dispositions* and *traces*, we have hitherto maintained a strictly psychological point of view. But as conscious process in general is correlated with nervous process, so psychological traces and dispositions may be regarded from another point of view as physiological facts. They are persistent modifications of nervous structure. Their existence, inter-connexion, and mode of operation are in the first instance revealed to us by purely psychological evidence. But there are many advantages in also considering them from a physiological point of view. When we are considering a disposition merely as a trace of previous consciousness, and a pre-condition of further conscious process, we may call it a *psychical disposition*. "When, on the other hand, we desire to consider exclusively the physiological side, the term *physiological disposition* is in place. When both are simultaneously to be taken into account, it is appropriate to speak of a *psycho-physical disposition*."*

* *Ibid.* p. 23.

CHAPTER III.

THE "FACULTY PSYCHOLOGY" AND ASSOCIATIONISM.

§ 1. *Introductory.*—There are two general theories of mental development of great historical importance. One of them—the "Faculty Psychology"—may be pronounced obsolete; and the other—Associationism—is at least obsolescent. But the ways of speaking and thinking which these theories pre-suppose have obtained such a hold on the popular mind, and, so far as they are false, they represent fallacies so natural, that it is worth while to give a critical account of them.

§ 2. *The "Faculty Psychology."*—"An individual fact is said to be explained by pointing out its cause, that is, by stating the law or laws of causation of which its production is an instance. Thus a conflagration is explained, when it is proved to have arisen from a spark falling into the midst of a heap of combustibles. And in a similar manner, a law or uniformity in nature is said to be explained when another law or laws are pointed out, of which that law itself is but a case, and from which it could be deduced."* Now a law of causation states a relation between two terms,—cause and effect, antecedent process and resulting product. Each of these must have a character of its own, by which it can be definitely conceived and described. Where this condition is not fulfilled there is no causal

* Mill, *Logic*, 9th edition, vol. i., p. 540.

law, and explanation is impossible. An effect cannot be its own cause, and cannot, therefore, afford its own explanation. But it is a fallacy of not infrequent occurrence to assign as a cause what turns out on examination to be only the effect itself, expressed in different language. This is a special case of the fallacy called "argument in a circle," and it usually consists in adducing as the cause of a special fact the general conception under which it is comprehended. The classical instance of this confusion is the reply of Molière's physician to the question, "Why does opium produce sleep?" "Opium," he answers, "produces sleep because it has a soporific tendency." It is to be noted that the fallacy does not lie in reducing the particular to the general, for this is the form assumed by all explanation. The generalised effect (soporific virtue) is adduced as the cause of the special effect (the production of sleep by opium). But in order to explain, we require a generalised *relation* between the fact to be explained and some *other* fact which determines it Thus, we may explain why a person goes to sleep by his having taken opium, but not by his possession of a power of somnolescence.

In psychology, the fallacy we have described needs to be guarded against with special care. The form which it is apt to assume is that of referring a mental state to a corresponding "faculty." To say that an individual mind possesses a certain faculty is merely to say that it is capable of certain states or processes. To assign the faculty as a cause, or as a real condition of the states or processes, is evidently to explain in a circle, or in other words it is a mere failure to explain at all. Thus, it is futile to say that a particular voluntary decision is due to Will as a faculty. It is equally futile to say that extraordinary

persistence in a voluntary decision is due to an extraordinary strength of Will, or of Will-power, or of the Faculty of Will. We explain nothing by asserting that certain mental processes in man have their source in the Faculty of Reason, or that certain other processes in lower animals have their source in the Faculty of Instinct. It may be true that conscience is a Compound Faculty including on the one hand the power of judgment, and on the other a certain susceptibility of feeling or sentiment. But such statements in no way account for the actual generation of a scruple or a twinge of conscience.*

The fallacy of what has been called "Faculty Psychology" may take either a positive or a merely negative form. A faculty may be explicitly regarded as an agency or real condition, producing its own special manifestation, and interacting with other faculties similarly conceived as agencies or real conditions. But such a position has rarely been maintained without disguise or equivocation. What we find is rather a tendency to rest satisfied with a reference of this or that state or process to a corresponding faculty without pushing the inquiry further so as to raise the question of causal explanation. Reference to a faculty, though it is futile from the point of view of causal explanation, may none the less have a good and useful meaning from another point of view,—that of classification. Now some kind of classification is a primary necessity for

* Locke, in criticising the phrase, "freedom of the will," has brought out very clearly the nature of this fallacy. "We may as properly say, that it is the singing faculty sings, and the dancing faculty dances, as that the will chooses, or that the understanding conceives; or, as is usual, that the will directs the understanding, or the understanding obeys, or obeys not the will; it being altogether as proper and intelligible to say that the power of speaking directs the power of singing, or the power of singing obeys or disobeys the power of speaking." *Essay on Human Understanding*, bk. ii., ch. 21, § 17.

the psychologist. To divide and arrange the various and fluctuating modes of consciousness in a distinct and orderly manner, so that each may receive an appropriate name,—this is in itself no small achievement. Many of the earlier psychologists were so absorbed in inquiries of this nature that they ignored the need for discussing questions of origin and development. They tacitly assumed that the whole problem was one of classification. If they had held and expressed this view with full distinctness, there would have been no ground for charging them with a fallacy of confusion, and the Faculty Psychology could not be justly used as a term of reproach. But they were by no means completely clear as to their own position. They did not fully realize that they were only classifying and not explaining. They would probably have repudiated the charge that they treated faculties as real agencies if the charge had been distinctly formulated. But none the less, they frequently used language which implied causal relation both between faculty and special process and between different faculties.

Indulgence in such modes of expression had a disastrous effect. It created an appearance of explanation without the reality, and in this way seriously retarded the progress of knowledge. For this reason the word "faculty" has almost passed out of use in modern psychology. But the fallacy does not necessarily disappear with the word in which it has so often found expression. We are by no means secure against it even in the present day. It is, therefore, necessary to warn the student against this peculiar mode of explanation in a circle, and to insist on the necessity of real explanation by definite conditions, giving rise to definite results, according to a fixed order.

§ 3. *Associationism.*—Faculty Psychology is valuable,

if at all, only as a scheme of classification. But the ultimate aim of science is to explain and not merely to classify. Hence, when once explanatory principles came to be clearly conceived and expounded the Faculty Psychology tended to disappear. Its greatest enemy in modern times has been the theory of reproduction as determined by Association. This theory, when pushed to an extreme, so as to exclude all other modes of explanation, becomes what is called "Associationism." Such writers as James Mill in England, and in a very different way Herbart in Germany, may be taken as types of it. The assumption which lies at the basis of Associationism is that mental conditions can only give rise to a mental product, if and so far as they reappear in the product as its components. From this point of view, to explain the origin of a state of consciousness is to enumerate its constituent parts and show how they came to cohere with each other by association. As all words are put together out of the letters of the alphabet, so all derivative mental states and processes are put together out of primary and simple modes of consciousness, arising from the stimulation of sensitive surfaces either outside or inside the body. In ordinary human consciousness these elementary sensations rarely if ever occur in their purity. They have all acquired associations, so that they now appear embedded in a cluster of revived residua of previous experiences. Thus, when an orange is perceived, what is immediately given in the way of sensation may be only yellow colour. According to the theory we are considering, the perception of the orange wholly consists in the more or less complete re-instatement of past sensations by the present sensation. The present sensation forms the nucleus of a cluster of revivals. The immediate ocular

experience reproduces the visual appearance of the orange from other points of view. It reproduces the smell, and the taste, and the character of the pulpy contents as presented to sight and touch.

It is admitted that for the most part the simple components of such a psychical complex can only be ascertained by laborious investigation; that the ordinary states of consciousness which common sense regards as ultimate are really not ultimate, but have an origin and development due to psychological conditions. The essential point is that these conditions are held to operate only in one special manner; they combine, and their combination is the effect which they produce. On this theory, causation and composition coincide.

§ 4. *Associationism criticised. "Mental Chemistry."*—In all psychical development some kind of association and reproduction is involved. So much may be conceded to associationism. Its defect lies in making the whole process merely reproductive, to the exclusion of other modes of psychical interaction, giving rise to new and not merely reproduced results. In the general course of nature causation and composition by no means always coincide. Conditions by no means always persist in their product as its component parts. Neither the sculptor's chisel nor its movements form part of the completed statue. The fire does not remain as an integral part of a burnt house, or a knife as an integral part of a wound. The theory which would reduce all mental production to reproduction, is, therefore, by no means a self-evident truth. Its claims to acceptance rest entirely on the verification which it may receive from experience. What kind of verification is necessary and attainable? It would seem at first sight that this question is easy to answer. If the producing conditions exist in the product itself we ought to be able to find them by analytic scrutiny of the

product. In material compounds this may not be possible, because the components may be so intermingled that they cease to be discernible by our senses. But it is the distinctive peculiarity of the combinations which are brought about by mental association and reproduction, that both the components and their union exist in consciousness. It would seem, therefore, that it ought to be as easy to detect the components of such a compound as to spell a word on phonetic principles.

But this conclusion is too hasty. To exist in consciousness is one thing. To be a discriminated and identified object of consciousness is quite another thing. Spoken language is composed of a limited number of elementary sounds. But language was spoken long before these elementary sounds were discovered and represented by an alphabet. So in articulating the sound of each letter combined movements of the throat, lips, tongue, and palate are involved. The corresponding sensations are experienced by everyone who utters the sounds. But they are only discernible by an express effort of analytic attention. Most of us never notice them at all. Again, the timbre of a musical note is due to its complexity. Overtones are united with a fundamental tone. These overtones are not as a rule separately discernible by an unpractised observer. But he may learn to discriminate them by adopting an appropriate method. If a simple tone is produced by itself and then compared with the complex note of which it is an overtone, and if this process is repeated with sufficient frequency, it becomes possible to distinguish the overtone as a separate component of the complex to which it belongs.

It is illegitimate to demand that the constituents of a complex mode of consciousness shall be immediately obvious

to simple inspection. But it is both legitimate and necessary to demand that they shall be ascertainable by a systematic process of reflective scrutiny conducted under favourable conditions. To affirm their presence where no scrutiny can detect them is simply to refuse to appear before the bar of experience, and judgment must go by default against those who assume such a position. If a certain mode of consciousness is alleged to consist of certain constituents, *a*, *b*, *c*, the only criterion of primary importance by which we can test their presence is systematic comparison. We must compare *a*, *b*, and *c*, severally, and, if possible, collectively, with what is alleged to be a product constituted by their combination.

It is necessary to bring the general plan of explanation which governs the procedure of the Association School to this test. Brought to this test it certainly collapses. One of the ablest members of the school, J. S. Mill, has virtually confessed its bankruptcy in his doctrine of "Mental Chemistry." "When many impressions or ideas are operating in the mind together, there sometimes takes place a process of a similar kind to chemical combination. When impressions have been so often experienced in conjunction, that each of them calls up readily and instantaneously the ideas of the whole group, those ideas sometimes melt and coalesce into one another, and appear not several ideas, but one; in the same manner as, when the seven prismatic colours are presented to the eye in rapid succession, the sensation produced is that of white. But as in this last case it is correct to say that the seven colours, when they rapidly follow one another, *generate* white, but not that they actually *are* white; so it appears to me that the Complex Idea, formed by the blending together of several simpler ones, should, when it really

appears simple (that is, when the separate elements are not consciously distinguishable in it), be said to *result from*, or be *generated by*, the simple ideas, not to *consist* of them. Our idea of an orange really *consists* of the simple ideas of a certain colour, a certain form, a certain taste and smell, etc., because we can, by interrogating our consciousness, perceive all these elements in the idea. But we cannot perceive, in so apparently simple a feeling as our perception of the shape of an object by the eye, all that multitude of ideas derived from other senses, without which it is well ascertained that no such visual perception could ever have had existence; nor, in our idea of Extension, can we discover those elementary ideas of resistance, derived from our muscular frame, in which it has been conclusively shown that the idea originates. These, therefore, are cases of mental chemistry; in which it is proper to say that the simple ideas generate, rather than that they compose, the complex ones."*

It is well worth while to examine this statement with some care. We must note that it contains a reluctant confession of the inadequacy of the Association theory, wrung by the stress of facts from one of its most devoted adherents. Mill shows his reluctance by the grudging nature of his admissions. He maintains the Association theory if and so far as he can find any plausible pretext for doing so. Thus he holds that our "idea of an orange really consists of the simple ideas of a certain colour, a certain form, a certain taste and smell, etc., because we can by interrogating our consciousness perceive all these elements in the idea." This is very plausible. For it is certainly true that when we ask ourselves what an orange is, we can only answer by enumerating such characteristics as those assigned. But the real

* *Logic*, 9th edition, vol. ii., pp. 441-442.

question at issue is quite different. The real question is whether in every moment in which we catch sight of an orange and know it for an orange, all these distinctive characteristics must be actually presented to consciousness. It will be seen at once that the necessity of such a collective resurrection of our previous experiences of oranges, whenever one happens to catch our eye, is by no means obvious. No doubt the visual appearance *means* all this to us in the moment in which we become aware of the object. But to say that *a* means *bcd* is one thing; to say that it drags *bcd* along with it is something altogether different. To suppose the contrary is, as we said before, like supposing that a five-pound note must always have five sovereigns literally wrapped up in it. The note will pass current instead of five sovereigns, and in like manner the visual appearance of the orange will in a manner pass current instead of the special experiences with which it has been conjoined. It will in certain ways and to a certain extent determine action, thought, and feeling, as these experiences will determine action, thought, and feeling, if they are actually present or actually reproduced in the form of ideas.

Though Mill clings to reproduction and association with all his might, he is in spite of himself compelled to confess their impotence to solve some of the most vital questions of genetic psychology. He is constrained to introduce a new principle of fundamental importance, which is, in a way, the contrary of that of association. In the products of associations, the producing factors persist in the result as its components. In the process of "generation" which Mill assumes the generating factors effect their own disappearance in giving birth to their product. Its life is their death. Yet Mill is by no means clearly aware that he is

deserting the association doctrine. He is rather of opinion that he is modifying and improving it. This is shown by his use of the term "Mental Chemistry." A chemical compound really is a compound. It really "consists" of its components and is not merely "generated" by them. Its weight is equal to their weight. By appropriate means the chemical combination can be dissolved so that the components again exist in a separate form. It is true that the compound has properties which do not belong to the components taken separately. But the components do not cease to exist in order to make way for the new properties as the generating factors in mental chemistry cease to exist in producing a new product. It may be said that though they do not cease to exist, they disappear just as the psychological factors disappear. But this is equivocation. The disappearance of the psychological factors is equivalent to their non-existence: the disappearance of chemical factors merely means that there are certain ways in which they cease to manifest their presence to us. The analogy between the chemical process and the mental, as the mental is conceived by Mill, appears more plausible from another point of view. In order that oxygen and hydrogen may combine to form water they must first be brought together. Similarly, according to Mill, the generating factors of a new mental product must first be brought together in a firmly associated group or cluster before they annul each other and give place to something radically new. For this reason, he appears to have imagined that he was still following the lines of the association theory. But in so thinking he evidently fell into a "fallacy of confusion." What he affirms is that a preliminary process of association and reproduction precedes the generation of a new and simple mode of consciousness. What he tacitly assumes is that

the process of generation itself is somehow reducible to association and reproduction. But this is mere confusion of thought. "Generation" remains an altogether distinct process from that which prepares the way for it. The fallacy had already been pointed out before Mill wrote in Thomas Brown's criticism of Condillac. "The great error of Condillac, as it appears to me, consists in supposing that when he has shown the circumstance from which any effect *results* he has shown this result to be essentially the *same* with the circumstance which produced it. Certain sensations have ceased to exist, certain other feelings have immediately arisen; these new feelings are, therefore, the others under another shape. Such is the secret, but very false logic, which seems to prevade his whole doctrine."* This applies *mutatis mutandis* to Mill. He held that because a certain grouping of mental elements precedes the emergence of a product distinct from each and all of them, this product must be the very elements themselves which have "melted and coalesced into one another." The metaphor of "melting and coalescence," if it is taken as more than a literary flourish, is quite unmeaning. Things which "melt and coalesce into one another" remain in existence after their union. The hydrogen and oxygen which unite to form water, persist, according to the principle of the indestructibility of matter, in the compound. It is only because of their persistence that they can properly be said to be compounded or to have coalesced. But there is no principle corresponding to the indestructibility of matter applying to modes of consciousness. They do not persist in their product, and therefore they do not "melt and coalesce" in it.

We have provisionally assumed Mill's theory that the

Philosophy of the Human Mind, Lecture xxxiii.

"generation" of a new mode of consciousness by psychological conditions must be preceded by an associative grouping of the generating factors. But, in reality, this assumption is neither self-evident nor justified by experience. Mill, at this point, merely shows the strength of the bias which led him to affirm the Association theory, even in the act of denying it. From another point of view also, his account of "mental chemistry" is, in the main, fictitious. He holds that the co-operative condition entirely disappears in giving rise to something new. This may happen in certain cases: but it is certainly not the prevailing rule, and above all it does not apply to the special class of cases which he refers to. Spatial perception, tactual and visual, in its various forms and modifications, is undoubtedly due to a vast complexity of co-operative conditions which do not appear in the result. But it is untrue that *none* of the contributory factors are discernible. Magnitude, as perceived by the eye, is *colour* extended or spread out. Shape, as perceived by the eye, is constituted by the boundaries of colour. In such perception there is always present at least visual sensation, and generally experiences accompanying eye-movements. The spatial character which belongs to these visual and motor experiences is indeed derivative and not a datum of primary sensation. It belongs to them, at least in the case of human beings, only in virtue of their previous combination in specific ways with other specific experiences, tactile, motor, and visual. None the less, the ocular perception of extended form and magnitude does not float loose in detachment from *all* the factors which contributed to its origin. For among these factors an essential part is played by the visual and motor sensations, which become endowed with a spatial character as the result

of the process. What happens is not that *a*, *b*, *c*, *d*, *e*, the antecedent conditions, all disappear beyond recognition and leave behind them an *x* quite disparate from all or any of them. What happens is rather that one of these conditions has, through interaction with the others, acquired a peculiar modification, so that whenever it recurs, it recurs in a profoundly modified form.

What is true in the doctrine of mental chemistry is the denial, express or implied, that reproduction by association is the only principle of fundamental importance controlling the course of mental development.

BOOK II.

SENSATION.

CHAPTER I.

DEFINITION OF SENSATION.

§ 1. *Sensation and Stimulus.*—One characteristic mark of what we agree in calling sensation is its mode of production. It is caused by what we call a *stimulus*. A stimulus is always some condition, external to the nervous system itself and operating upon it. This stimulus may consist in physiological change originating in the organism itself, as in the case of organic sensations, or in physical conditions external to the organism, which act on the peripheral organs of sense, and by means of afferent nerves affect the central nervous system. The change in the internal state of the body which gives rise to organic sensation may be initiated, in the first instance, by an external stimulus acting on peripheral organs as in the case of tickling. We have also to count among the various modes of stimulation the irritant effect of certain variations in the nature and the distribution of the blood-supply within the brain, leading to hallucinations. Causal dependence on some kind of external condition is essential to the conception of sensation.

It is above all things important to distinguish the cause of sensation from the object of sense-perception. A man examining a material thing present to his senses may successively or simultaneously see it, feel it, weigh it in his hand, hear the sound it makes, smell it, and taste it. In so doing he perceives its sensible qualities, such as colour, hardness, weight, odour, and flavour. He does so by means of the sensations which are produced in him by the varying relations of his sensitive organism to the object. But the sensible qualities perceived are by no means identical with the cause of sensation. The colour-sensation, for instance, is due to a vibratory motion of the particles of the luminiferous ether, giving rise to certain chemical or physical changes in the organ of vision, and so to a certain modification of connected parts of the nervous system. But these conditions are not what a man sees when he perceives the colour red or blue. Similarly, the weight of the object as perceived is by no means to be identified with the changes produced by it in the skin, muscles, tendons, etc., which occasion the sensations necessary to the perception of the weight.

Sensations are essential to the perception of things and their qualities; but in the conception of what constitutes a sensation we abstract from the cognitive function which belongs to it as an element in the perception of an object. The vital point on which we fix attention is that a sensation is a mode of consciousness produced by a specific mode of stimulation, and having its own specific nature ultimately determined by the conditions which produce it. We have noted that the producing conditions may, in the first instance, be external to the organism. But they can only affect the nervous system by first operating on those parts of the organism which we call the organs of sense.

Thus the changes in the organ of sense, and the subsequent processes by which these changes affect the nervous system, constitute the essential antecedents of the sensation.

§ 2. *Sensory Elements.*—If I look at grass, I have the sensation of green. If I look at snow, I have the sensation of white. I can assign no psychological reason why in the one case the sensation is that of white and in the other that of green. The difference can only be accounted for by the different way in which my eye is affected by different kinds of light. So in all cases the qualities of sensation must be ultimately accounted for by reference to the nature of the stimulus.

If I do not actually *see* grass or snow, but summon up mental pictures of them in my mind's eye, the qualities of greenness and whiteness are present in my mental image as they are present in actual perception. Now these qualities would not be present in the mental image unless they had been previously produced by the operation of an external stimulus. For this reason, some writers would apply the term *sensation* to these qualities even when they appear in the mental image. Both in actual perception and in the mental image they defy psychological analysis, and can be ultimately accounted for only by reference to external stimulation. There is, however, an objection to applying the word *sensation* to both cases indifferently. Though greenness appears both in the perception and in the mental image of grass, it appears in a different manner in each instance. The present operation of the external stimulus gives it peculiar intensity, steadiness, and other distinctive characters, which do not belong to it in the mental image. It is better to restrict the term *sensation* to the special form of consciousness which accompanies the actual operation of the stimulus. The qualities of sensation

as they appear in mental imagery may be called *sensory elements*, but not *sensations*. The term *elements* indicates that their peculiar nature cannot be psychologically accounted for,—that ultimately it can only be explained by reference to an external stimulus. The word *sensory* indicates that their existence pre-supposes the previous existence of corresponding sensations.

§ 3. *Mere Sensation.*—In defining sensation we have disregarded the cognitive function which it may discharge as a constituent element in the perception of an object. It does not follow from this that sensation can actually exist without cognitive function. This is a question to be separately considered on its own merits. We may formulate it as follows: Is there such a thing as *mere* sensation? We owe to Professor Stumpf an argument which seems to settle this question in the affirmative. It is based on the fact that within limits we can vary a stimulus without producing any perceptible difference in the object cognised. If this variation in the stimulus is accompanied by variation in the sense-experience, then we have a variation in the sense-experience which makes no difference to cognition. There is a difference in mere sensation, but not in perception. That, as a matter of fact, this is so may be demonstrated as follows. We may vary the physical conditions on which the pitch of a musical note depends, so as to produce a graduated scale of notes increasing or decreasing in pitch. Symbolise the series by P_1, P_2, P_3, P_4, P_5, ... P_n. Now, if the variation of the physical conditions is sufficiently gradual, P_1 may be quite indistinguishable from P_2, and similarly P_2 may be quite indistinguishable from P_3, and P_3 from P_4. None the less, P_1 will be perceived as distinctly different from P_4. But this would be impossible unless the change in the physical

conditions were accompanied by a change in the sensation, even when the change is imperceptible. If the pitch-sensation P_1 is regarded as identical with the pitch-sensation P_2, merely because the one note is indistinguishable from the other, and if in like manner P_2 is regarded as identical with P_3, and P_3 with P_4, and so on, then P_1 must be identical with P_n, and it would be impossible that any perceptible difference should ever arise. The same argument may be applied to a gradual increase in heat or weight or pressure or brightness. The burden on a man's back may be increased by sufficiently gradual additions from an ounce to a stone without his noticing the successive increments. If these successive increments made no difference to his sensation, the sensation produced by a stone weight would be all the same to him as the sensation produced by an ounce.

The merit of Stumpf's argument lies in the exact and cogent form into which it is thrown. But the same point may be brought out by an appeal to common experience. It is easy to show that there is by no means a complete coincidence between the existence of sensations and their cognitive function. They may exist as possible material for perceptual consciousness, without being actually utilized. "At this moment I am thinking about psychological topics. I receive at the same time a multitude of diversified impressions from surrounding things which certainly enter into my total experience. But if I refer them to an object at all, I do so in a very indeterminate way. My perceptual discrimination is very far from keeping pace with the differentiation of the sensory data as immediately experienced."* The room is well-lighted, and the sun is shining in at the window. But, with my

* *Analytic Psychology*, vol. i., p. 18.

thoughts otherwise occupied, I do not notice this. My thoughts might be similarly occupied in the twilight without my noticing that it was twilight. But my total experience would be different in the two cases. The kind and degree of illumination modifies my consciousness, even though I do not take cognisance of it. In like manner, I often, in becoming aware of a sound, am at the same time aware that I have been hearing it for some time past without being aware of it. The corresponding sensation was present in my consciousness though I did not notice the sound.*

§ 4. *Sensation as Cognitive State distinguished from Sensation as Cognised Object.*—We must distinguish the knowledge, of which sensations are the vehicle, from the knowledge which has for its object sensations themselves. It is true that without the sensations we can have no knowledge of them: but it is not true that whatever we know by means of sensations is knowledge of these sensations. We must distinguish between what a sense-experience means and what it is in its own intrinsic nature. The image thrown by an object on the retina of the eye decreases in magnitude as the distance of the object increases. This involves a corresponding difference in the visual sensation. When we deliberately fix our attention on the sensation and its phases, we may, with practice and by using appropriate means, notice this difference. We may become aware that a man entering a room and approaching us apparently increases in stature. But for the most part we ignore these variations in our experience. None the less, they fulfil a cognitive function. They help to determine our perception of the distance of the object seen. It is the business of the artist to attend to these

* *Cf.* Bk. I., ch. I., § 5.

and other differences in visual sensation, and reproduce them in his pictures. Only in this way is he enabled to effect an artistic illusion. He must reproduce differences of colour and of shading, etc., and differences due to the varying way in which objects in varying positions affect the eye. But for all this he needs a special training. He has to learn to notice what nobody notices in ordinary life. In ordinary life, people attend only to what the sense-experience practically means. The artist must acquire the power of attending to the intrinsic nature of the sense-experience itself.

Similarly, in psychology, we have to attend to sensations, as such: we have to examine their attributes as psychical states, and not merely their meaning as vehicles of knowledge. The two points of view only partially coincide. If we compare the colour *red* as a quality of a material object with the colour *red* as a quality of the corresponding sensation, we find that redness as immediately perceived is an attribute common to both. The difference lies in the different relations into which it enters in the two cases. As a quality of the thing, it is considered in relation to other qualities of the thing,—its shape, texture, flavour, odour, etc. As a psychical state, it is considered as a peculiar modification of the consciousness of the percipient, in relation to the general flow of his mental life. But this is not the only difference. When we are attending to redness as a sensation, we take cognisance of many characteristics which are usually ignored when we are only interested in it as a quality of material objects. The manifold variations which the colour of an object undergoes under varying phases of illumination are, to a large extent, ignored in ordinary perception, because they make no practical difference in the nature of the object as a

physical thing. The colour is regarded as the same, and the illumination alone as varying. But for the psychologist, whose interest is in the sensation, and not in the physical object, these variations are of primary importance, and he, like the artist, must fix attention upon them.

Sensations, as such, therefore, are psychical states. These psychical states, as such, become objects only when we attend to them in an introspective way. Otherwise they are not themselves objects, but only constituents of the process by which objects are cognised.

CHAPTER II.

THE SENSATION-REFLEX.

§ 1. *As distinguished from Physiological Reflex.*—"We may define a *reflex act*," says Dr. Waller, "as the *immediate* motor response to centripetal excitation."* The emphasis here is on the *immediacy* of the response. The reaction depends directly on the stimulus, so that it always occurs in an invariable and inevitable manner whenever the stimulus is repeated, and is discontinued when the stimulus ceases to operate. If we irritate with acetic acid the thigh of a frog whose cerebral hemispheres have been removed, the leg is jerked away. By using a suitable apparatus it may be arranged that whenever the leg is thus jerked away it comes in contact with a hot plate; when this happens, it is jerked back again. On being again irritated, it is once more jerked away and once more comes in contact with the hot plate, when it is again withdrawn; and so the process may go on until the limits of fatigue are reached.

A reflex act may be performed without being accompanied by change in consciousness, or at least by any conspicuous change. Coughing and sneezing are reflex acts, due to irritation of the mucous membrane. But a person may sneeze or cough either unconsciously or consciously.

Human Physiology, p. 294.

Perhaps the unconsciousness is in any case not complete; but it is often very nearly so. The consciousness on the other hand is sometimes very keen, as when the irritation of the mucous membrane is violent. Now those reflex actions which, roughly speaking, take place unconsciously, may be described as physiological; those which take place with consciousness may be described as sensational. There is no reason for believing that the physiological reflex is effected through nerve-fibres other than those which convey and effect the sensation-reflex.

The sensation-reflex is the most primitive form of mental life which is distinctly recognisable. If, then, we fix the conditions under which the physiological passes into the sensational reflex, we thereby fix the conditions under which mental life first appears in a definite form. These conditions appear to be two-fold. In the first place, the merely physiological reflex is found where the action takes place regularly and uniformly in response to stimulation which is uniformly and regularly recurrent. The sensation-reflex, on the other hand, takes place on a comparatively special emergency, which is only of occasional occurrence. In the second place, much depends on the degree in which the mind is pre-occupied by higher processes. A man may cough unconsciously when he is absorbed in some interesting topic, although in a less pre-occupied condition of mind the cough would have been a sensation-reflex. The more pre-occupied he is, the more intense must the irritation be in order to produce an appreciable sensation. Taking up the first point, it is plain that those reflex movements which belong to the ordinary and normal routine of the vegetative life of the organism are almost wholly physiological. The heart's beat and its modifications, the constriction and dilatation of the

blood-vessels, breathing, swallowing, the secretion of saliva, and the like, are not normally accompanied by distinctly appreciable sensations. I say *distinctly appreciable* sensations, because, in all probability, they do in their totality contribute to determine the state of consciousness as a whole, giving it a certain tone or modality. But the effects of the various organic processes blend into a vague total experience. Their several effects are not separately appreciable. The most we can say is that, as Dr. Michael Foster puts it, "if the whole of our abdominal viscera were removed, we should be aware of the loss as a change in our common or general sensibility."* On the other hand, when a stimulus is of comparatively occasional occurrence, and prompts a special combination of movements to meet a special emergency, the concomitant experience may disengage itself from the vague mass of general sentience and become salient in consciousness. The more special the occasion, and the more intense the stimulation, the more definitely does the sensation-reflex stand out in its own proper character as distinguished from the physiological reflex. Coughing is an act required only now and then, when irritating matter happens to be lodged in the throat. Hence in waking life it is usually a sensation-reflex, when the mind is not otherwise too much pre-occupied, or when the irritation is intense enough to counteract even a strong pre-occupation. The act of swallowing belongs to the fixed routine of vegetative life, and is not in the ordinary course of things accompanied by a separately appreciable experience. But if we touch the back of the tongue with a finger, or tickle it with a feather, this is an interruption of routine requiring a special adjustment adapted to the special emergency, which cannot be made without a well-marked modification

* *Text-Book of Physiology*, book iii., ch. vi., p. 1421.

of consciousness. So, breathing is normally unconscious ;* but if any difficulty or obstruction occurs in the respiratory process, it at once becomes accompanied and prompted by painful sensations.

On the second point we need not say much. Where the mind is much pre-occupied, we may have a physiological reflex where otherwise we should have had a sensational reflex. As an extreme example of the effect of mental pre-occupation we may refer to the soldier who in the heat of the battle is unaware of being wounded. What most concerns us is the fact that at the lower levels of organic life, where action is largely or mainly reflex, so that higher processes play a comparatively small part, there can be very little mental pre-occupation. Thus, the lower we descend in the scale, the stronger is the presumption that a reflex act adapted to meet an occasional emergency is of a sensational and not merely of a physiological character.

§ 2. *Distinguished from Perceptual Reaction and Ideational Reaction.*—In sensation-reflexes specially coordinated movements follow the mere existence of a sensation as an isolated and transient experience ; the movements are not prompted and guided by any meaning which the sensation may convey. Where movement is determined by what the recognised quality of the sensation points to, by what it gives warning of, the reaction is to that extent perceptual or ideational, not merely sensational. The distinction may be illustrated by the difference between sneezing and repressing a sneeze. The sneeze follows the irritation of the mucous membrane. This is a sensation-reflex. It arises from the mere existence of the feeling of irritation. On the other hand, the

* This means that the breathing-sensations are normally merged in the mass of general sentience : they are not normally prominent in consciousness, as they are when breathing is obstructed.

repression of an inconvenient sneeze, or the turning of the head aside, or similar measures of precaution, are at least perceptual acts and may involve distinct ideas. The agent performs them because he recognises the irritation as of a certain kind pointing to certain consequences which are inconvenient at the moment. What determines his conduct is the cognitive function of the sensation, not its mere existence as a feeling,—a transient and isolated experience. The presence of ideal representations in the way of mental imagery is not necessary. We may not be able to spare time to call up a mental picture or a verbal description of the consequences of sneezing in a person's face. A recognised sensory quality comes before the mind as having a certain special significance: it presents itself as a fragment of a whole; it points beyond its own existence; in virtue of this cognitive value which it possesses, it prompts to a certain line of action, such as the repression of the sneeze.

In this case, a sensational impulse comes into conflict with a perceptual, and it is a matter of doubt which will prevail. Many sensational impulses, when they reach a certain intensity, become quite uncontrollable even in human beings; this may help us to understand the almost mechanical way in which they repeat themselves without modification by experience in some of the lower animals, whose perceptual consciousness is comparatively little developed. For the power of learning by experience first arises with perception, with meaning and the acquisition of meaning. The purely sensory reaction, unguided by higher modes of consciousness, follows inevitably its appropriate stimulus. Thus a moth or a "daddy-long-legs" flies again and again into the flame in spite of the obviously painful result. Here we have apparently a sensory reaction uncontrolled by

perceptual consciousness. The brightness of the flame produces an immediate sense-impulse to move in its direction. But the light-sensation is not correlated with other experiences; it does not acquire a warning significance.

From the biological point of view, the action required in response to a stimulus is one which serves to maintain the life and well-being of the organism. The appropriate response may be determined by the special nature of the agency acting on the organism; and it may be more or less delicately differentiated according to the varying nature of this agency. In so far as this is the case, the reaction is perceptual rather than sensational. On the other hand, many agents differing in their own nature may impress the organism in a similar manner, and so give rise to a similar response. In so far as this is the case, the reaction approximates to the purely sensational type. Thus, when a part of the body is cut or bruised or otherwise suffers direct injury, it matters not at the moment whether a stone, a piece of wood, or a piece of iron, does the mischief. In each case, the rapid withdrawal of the part of the body affected, or of the body as a whole, is the appropriate reaction, and follows directly on the unpleasant sensation. It depends on the mere existence of the sensation as a painful experience; it does not depend on the specific nature of the sensation being recognised or known for what it is; this is only necessary when the specific nature of the sensation points to something beyond itself—to some special kind of material agent; and when the organism has to adjust itself in reference not to the immediate operation of this agent, but to its other qualities and modes of behaviour, as when an animal perceives its prey in the distance. Such adjustment requires a prospective attitude of mind, a state of expectant attention

and of preparation for future action. It is the beginning of a systematic coordination of successive actions, determined by the whole nature of the object which thus reveals its presence. Where the appropriate reaction takes place, so to speak, on the spur of the moment, and is not the commencement of a systematic combination of successive acts, so directed as to secure some remoter good or avert some remoter evil, it need be determined by nothing but the sense-experience as an immediate feeling, independently of its cognitive function.

§ 3. *Conative and Hedonic Aspect of the Sensation-Reflex.*— The movements arising from sense-impulses display in a simple and distinct manner an antithesis which pervades all manifestations of mind. They are directed either, on the one hand, to the removal, avoidance, or abatement of the stimulation which excites them, or, on the other, to its detention, maintenance, or increase. The first kind of reaction may be called positive, and the second negative. The psychical states which find expression in these antithetic types of movement, show a corresponding contrast of a twofold character. The reaction of avoidance or repulsion is the outward manifestation of disagreeable consciousness, and also of aversion, or, as Hobbes would say, of "endeavour fromward;" the positive reaction is the manifestation of agreeable consciousness and also of appetition, or "endeavour toward." Appetition and aversion are the fundamentally antithetic directions of psychical activity; their contrast is a contrast which belongs to the conative or striving aspect of consciousness. Pleasure and displeasure are the fundamental antithetic modes of feeling-tone. Their contrast is a contrast which belongs to the hedonic aspect of consciousness. In the purely sensory impulse, appetition always actually coincides with pleasure,

and aversion always actually coincides with pain. At higher levels of psychical life, the coincidence between positive conation and positive tone of feeling, and between negative conation and negative tone of feeling is by no means complete. After a fashion, the sensation-reflex may be described as an activity inasmuch as it has a conative aspect in the way of appetition or aversion. But the activity involved is of a rudimentary and primitive kind, just as the process itself is of a rudimentary and primitive kind. The sensation-reflex consists in a single simultaneous act; in this respect it is contrasted with perceptual process, which may, and usually does, combine a series of distinct and successive acts in the unity of a single action directed towards a single end. Thus, in the case of perceptual activity, we may speak of progress towards an end, which may or may not be interrupted or obstructed in its course. In the case of the sensation-reflex, on the contrary, the word "progress" has little or no meaning. It is for this reason that in it appetitive conation and agreeable feeling completely coincide. This is not the case in perceptual process, because disagreeable feeling may arise through obstruction of appetitive activity, which none the less remains appetitive although it has become disagreeably toned. We are endeavouring to hit the nail on the head even when we miss it.

We may briefly describe the physiological process involved in a sensation-reflex as follows. A stimulus disturbs the equilibrium of the nervous system. The subsequent process consists in the recovery of nervous equilibrium. When this is accomplished the end of the whole activity is attained, and it ceases. To put it simply, the excitement is allayed. The tendency to equilibrium is the physiological correlate of what on the psychical side we call conation,—the striving

aspect of consciousness. But the nervous system may regain its balance in two opposite ways. It may be that it can only do so by removal of the stimulation which starts the whole process. On the other hand, it may happen that the continuance of the stimulation for a longer or shorter time is a positive condition of the reattainment of equilibrium. In the first case, we have pain and aversion; in the second, pleasure and appetition. As a rule, the more important is the perceptual function of a sensation, the less emphatic is its feeling-tone, and the more it approximates to a mere sensation concerned in merely sensory reaction, the more emphatic is its feeling-tone.

§ **4.** *Relative Purity of Sensation-Reflex.*—The same sensation may, by its mere existence as a momentary experience, issue or tend to issue in a certain movement, and at the same time it may also determine action by its significance. Thus the perceptual may mingle with the sensational impulse, so that in practice it may sometimes be difficult to draw the line between them. The two modes of consciousness blend in intricate ways and in varying degrees.* In general, they bear an inverse ratio to each other. The lower we descend in the scale of animal life, the more important is sensation; the higher we ascend, the more important is perception. It should, however, be clearly understood that in theory the distinction between them is sharp and clear. This is peculiarly evident when the perceptual impulse depending on the meaning of a sensation is contrary to the sensational impulse itself, as when we repress a coming sneeze.

* This applies almost, if not quite, universally to the developed human consciousness. The nearest approach to the pure sensation-reflex in adult human beings is the reaction which accompanies intense bodily pain, especially if it occurs suddenly without the subject being prepared for it beforehand.

CHAPTER III.

DIFFERENTIATION OF SENSE-EXPERIENCE, AND ITS PSYCHICAL SIGNIFICANCE.

§ 1. *Differentiation and Integration.*—The lower we descend in the scale of animal life, the more important is sensation: the higher we mount, the more important is perception, in other words, the intrinsic intensity and feeling-tone of sensation counts for less; its meaning counts for more. The reaction which it sets up is directed not so much to the maintenance or removal of the present stimulation as to the attainment of remoter ends.

This graduated difference in the relative prominence of sensation and perception is accompanied and manifested by a corresponding variation in the nature of sense-experience itself. The more developed is perceptual consciousness the more delicately differentiated is sense-experience. In other words, there is a finer correspondence between differences in the nature of the external stimulus, and differences in the sensation produced. With this finer differentiation is connected more definite restriction. The more delicately discriminated sensations are, the more capable they are of co-existing simultaneously in the same consciousness without mutual interference or amalgamation. "Colours," says Dr. Ward, "are with us so distinct from sounds that—except as regards the drain upon attention—there is

nothing in the intensest colour to affect the simultaneous presentation of a sound. But, at the beginning, whatever we regard as the earliest differentiation of sound might have been incopresentable with the earliest differentiation of colour, if sufficiently diffused, just as now a field of sight all blue is incopresentable with one all red. Or, if the stimuli appropriate to both were active together, the resulting sensation might have been what we should describe as a blending of the two, as purple is a blending of red and violet."* Thus "increased differentiation seems to be intimately connected with increased 'restriction.'"† With differentiation and restriction there is loss of the intensity and of the intrinsic pleasantness or painfulness of the sensation itself. The intensity and feeling-tone of sensation need to be strongly emphasised, where the reaction depends directly on the mere existence of the sensation, as such. In so far as the reaction depends on the meaning of the sensation, and not on its mere existence, the important point is that its special quality should correspond accurately to the special quality of the stimulus. Any direct effect produced by its own intrinsic intensity and feeling-tone would interfere with its value as a vehicle of meaning—as an indication of something beyond its own existence. Thus, as perceptual consciousness becomes relatively more prominent and important, sensation is more delicately differentiated, more definitely restricted, less intense, and less strongly toned in the way of pleasure or pain.

§ 2. *Differentiation of Sense-Organs.*—Degree of discriminative sensibility corresponds broadly to the complexity and differentiation of the organs of sense. If the nerve-

† Article "Psychology," *Encyclop. Brit.*, ninth ed., part xx., p. 46.
* *Ibid.*

fibres running to the skin in human beings are laid bare and directly stimulated, "then, however they be stimulated, be the stimulus weak or strong, if consciousness be affected at all, the affection takes on the form of pain; psychological examination of the subjective result discloses nothing that can be called a sensation of touch."* Touch- or pressure-sensations, delicately differentiated as they are, and almost neutral in tone, and capable of combining in one moment of consciousness a great variety of qualitative differences, can only be developed by the help of special terminal organs. But cutaneous pain-sensations, and all organic sensations which are vague, diffusive, and strongly-toned, arise without the help of specially differentiated end-organs. Now, in the ascending scale of animal life, we find a growing complexity and differentiation of the terminal organs of sense and of their nervous connexions, marking a correspondingly graduated displacement of sensational by perceptual consciousness.

In following the ascending scale of animal life, we find a gradual evolution of specialised structures for the reception of special kinds of external stimulation: beginning with those which are scarcely distinguishable from the general surface of the body, and ending with such elaborate organs as the human eye or ear. The best illustration is drawn from sight, because most is known about it. It must be understood that the word "sight" is here used to mean merely "sensitiveness to light." It must not be assumed that the sensations produced by luminous vibrations are the same in the higher organisms as in the lower.

In some lowly organisms which have no eyes the general surface of the body appears to be sensitive to light. This is the case with earth-worms and newts. "It is easy to

* Foster, *Text-Book of Physiology*, p. 1127.

imagine," says Lubbock, "that in unpigmented animals whose skins are more or less semi-transparent, the light might act directly on the nervous system even though it could not produce anything which could be called vision."* Certainly it would be misleading to call the experience of the earth-worm a visual sensation. We must rather suppose it to be a kind of general organic discomfort.

The most rudimentary beginning of a special structure for the reception of light-stimulation consists simply in groups of pigmented cells with a nervous connexion. The pigmented material occurring in a semi-transparent organism arrests and absorbs the light. The limpet has eye-spots of this simple kind "on the outer side of the tentacles where the eyes are situated in more highly organised species."† The skin is thrown into a pit within which the epithelial cells are elongated and pigmented.

The next step is the development of a lens for condensing the light in the manner of a burning-glass. Some species of worms have only pigmented cells, others have a concentrating apparatus. These simple eye-spots, consisting of pigmented cells and a vitreous body or condensing lens, may exist in great numbers over the general surface of the organism. Thus in a species of worm called "Polyophthalmians" there is a series of eye-spots "along the sides of the body, in pairs from the seventh to the eighteenth segments."‡ Such rudimentary organs can only serve to render the creature sensitive to degree of illumination, to the transition from light to darkness; they thus make possible a protective reaction when the shadow of an approaching object falls on the animal.

* *The Senses of Animals*, p. 207. † Lubbock, *op. cit.*, p. 139.
‡ *Op. cit.*, p. 134.

The next important step is the development of a rudimentary retina, essentially consisting in a layer of rod-like nerve-endings. The eye of the snail is situated on its hinder horn or tentacle. It consists of a cornea or transparent horny integument, a lens, and a retina composed of three layers, (1) the rods, which are the proper organ of vision, (2) a cellular layer, (3) a fibrous layer. "In all probability the eye does little more than enable the snail to distinguish between light and dark." "It does not seem to be aware of an object unless it is brought within a quarter-of-an-inch of its tentacle."* The rods of the retina in which the optic nerve terminates in all probability merely render the animal differentially sensitive to different directions of the light. In many animals which possess these retinal rods the formation of an image in any way comparable to that thrown on the retina of the human eye is impossible from the position and convexity of the lens. These eyes with rudimentary retinas, more or less sensitive to direction, may be spread in great numbers over the surface of the body. There are certain species of a genus of sea-shore slugs called *Onchidium* which have these scattered eye-spots in varying numbers, some a hundred, others as few as twelve. The number differs in different individuals of the same species, and the eyes "are continually growing and being reabsorbed."† The back of the *Onchidium* contains a number of glands, each opening by a minute pore; and it has been suggested that when warned by the shadow of certain flying-fish which come out of the sea to prey upon them, the little slugs emit a shower of spray and so drive off their enemy.

The next stage in the development of the eye is the

* Lloyd Morgan, *Animal Life and Intelligence*, p. 293.
† Lubbock, *The Senses of Animals*, p. 143.

formation of a retinal image by means of a lens; it is necessary for this that each diverging pencil of rays from a point in the object shall be brought again to a focus in one point, and in only one point, of the retina. The delicacy and perfection with which this is effected depends on the complexity of structure of the retina, on the nature of the lens, and on the power of adjusting it for different distances. Cuttle-fish and their allies have well-developed apparatus for the formation of images. So have vertebrate animals, but of course in varying degrees. Many fishes do not distinguish their food (worms) at a greater distance than three or four feet. On the other hand, some of them have very accurate vision for short distances. "I have often seen," says Mr. Bateson, "a large Wrasse search the sand for shrimps, turning sideways, and looking with either eye independently, like a chameleon. Its view is so good that it can see a shrimp with certainty when the whole body is buried in grey sand, excepting the antennae and antennae plates."* Some reptiles and amphibians have similar accuracy of vision at short distances.

Besides this main line of development of the visual organ which leads up to the eye of vertebrates, with its apparatus for forming a distinct image by means of a lens and delicately sensitive retina, there is a branch line which leads to the compound or facetted eye of insects and of crustacea such as crabs and lobsters. The surface of these compound eyes is divided up into a great number of hexagonal areas, each of which is called a facet, and in some insects forms a little lens. A kind of dragon-fly is stated to have twenty thousand of these hexagonal facets. Beneath each facet is a crystalline cone, with its base towards the facet and its apex turned inwards, where it

* Quoted by Lloyd Morgan, *Animal Life and Intelligence*, p. 287.

ends in great elongated cells; in the midst of these there is a nerve-rod. Dark pigment is developed round each of the cones. "Starting from a simple form of eye consisting of a lens and a nerve-fibre, we should arrive at the compound eye by bringing together a number of such eye-spots, and increasing the number of lenses, while the separate cells beneath each lens coalesced to form a single crystalline cone and rod." As regards the way in which these eyes perform their function, there has been much dispute. But it is now pretty clearly made out that the facetted organs taken collectively fulfil in a different way the same office as the lens in the eye of vertebrates. Only those rays of light which go straight through a crystalline cone affect the nerve-rod. All the rest which strike the cones obliquely are absorbed by pigment. Thus, each of the cones conveys to its own nerve-rod a single minute spot of light coming from a single point in the field of view, and from that point only. The result is what Lloyd Morgan calls a "stippled image."* The range of vision with such eyes is much smaller, and the image which they form must be far less accurate and distinct than in the higher vertebrates.

* *Op. cit.* p. 290.

CHAPTER IV.

LIGHT-SENSATION.

§ 1. *Introductory.*—Having given a general account of the nature of sensation, and of the sense-reaction, we now pass to the special senses, beginning with those we know most about, sight and hearing. Sight is a vehicle of spatial perception, and it is so in part because of the peculiar nature of visual sensation. But we shall postpone treatment of this part of the subject, until we come to deal with perceptual as distinct from sensational consciousness. At present we are only concerned with the peculiar modifications of consciousness specifically corresponding to differences in the nature of the physical stimulus which we call light. In other words, we have to deal with colour-sensations, including the neutral tints, white, black, and intermediate greys.

§ 2. *Nature of the Stimulus.*—Physically considered, light is an undulating movement of the particles of a generally diffused medium called the luminiferous ether. For our purposes, we may represent this undulating movement by the waves which pass along a rope, when it is fixed at one end, and jerked up and down by the hand at the other. As the wave traverses the rope, what travels along it is not of course the material particles of the rope themselves, but only a form of movement which is transmitted from one

set of particles to another. The hand may move more or less quickly; the more quickly it moves, the shorter are the waves. In the undulating movement the particles of the rope first rise above and then fall beneath their position of equilibrium when the rope is at rest. They rise to a crest, and sink into a hollow. The length of the wave is measured by the distance between the point at which this movement begins and the point at which it terminates. Longer waves traverse the rope in the same time as shorter ones; hence the shorter wave must be more frequently repeated in the same time. Thus the shorter the wave the shorter time it takes to complete itself. The *amplitude* of the wave must be carefully distinguished from its *length*. The hand, while continuing to repeat its movements in the same time, and consequently producing waves of the same length, may take a more or less extended swing. The more extended the swing, the greater is the amplitude of the waves that traverse the rope. The particles of the rope rise higher and sink lower; their crests are higher and their hollows deeper. Suppose now that the hand, in making its excursion to and fro, also trembles. Two different kinds of impulse are then communicated to the rope, each of which separately would give rise to waves of different length. The result is waves of a more complex form which can be mathematically explained as due to a combination of the waves which the separate impulses would severally produce.

Thus we can distinguish three characteristics of an undulating movement: (1) wave-length, (2) amplitude, (3) simplicity or complexity. In the case of light, each of these characters of the physical undulation is specially connected with a corresponding characteristic of visual sensation. Differences of *wave-length* are specially connected

with differences of colour-quality other than those which are constituted by degrees of paleness or darkness, viz. by more or less resemblance to white or black. Colour-quality in this restricted sense is called *colour-tone*. For example, the difference between yellow and green, or between yellow-green and a still yellower green, is a difference of colour-tone. The difference between yellow and yellowish-brown is difference in saturation due to a darkening of the yellow. The *amplitude* of the wave is specially connected with the intensity of the sensation. Any specific colour-tone, such as green or red, produced by light of a certain wave-length, may be made brighter or less bright by increasing or diminishing the intensity of the light, viz. the amplitude of the vibration. It may become brighter without alteration of its colour-tone. If we have a series of greys including what we call white, arranged in a graduated scale of brightness, it is possible to fix the brightness of a given colour, such as green, by comparing it with the greys. It is judged to be equally bright with one of them, and more or less bright than the rest. The *complexity* of a wave determines what is called the *degree of saturation* or purity of the corresponding colour. We can, as we have seen, compare a green with a grey or white in respect of intensity or brightness: but we can also compare it in another respect: we can ask how far the green resembles the grey in quality. It may be a greenish grey or a greyish green, or apparently a pure green. The more it approximates to grey, the less saturated it is, and the more free it is from any apparent admixture of grey, the more saturated it is.

It must not be supposed that colour-tone is determined solely by wave-length, intensity solely by amplitude,

and degree of saturation solely by complexity. It is only within certain limits that the physical intensity of light can be varied without affecting colour-tone. Variation in the intensity of the light also affects saturation; increase makes the colour whiter, and decrease makes it darker. Wave-length not only determines colour-tone, but also helps to determine brightness. Some colour-tones are brighter than others, even though the physical stimulus is less intense. Complexity of vibration is a very important factor indeed in determining colour-tone. The same colours which are produced by simple waves can be produced by complex waves also, though in a less pure or saturated form. White or grey results from a combination of lights of all wave-lengths, and also from various other combinations. In ordinary daylight, all wave-lengths are combined.

§ 3. *Structure of the Eye.*—For anatomical detail we must refer to the text-books of physiology. The eye as a whole is analogous to a photographic apparatus. "In it a camera or dark chamber of notable size exists similar to that which a photographer uses, having a lens in the fore part, and a sensitive curtain at the back. . . . . When the photographer looks in at the back of his camera, he sees on the ground glass plate the image depicted which he wishes to photograph, placed upside down, but faithfully delineated in all its colours; and such an inverted landscape is formed in like manner in the back part of each of our eyeballs. And as the photographer adjusts the focus of his instrument by altering the position of the lens, screwing it nearer or further from the screen, so we adjust the focus of our eye instinctively according to the distance of the object looked at, not indeed by changing the position

of the lens but by altering its form so as to make it stronger or weaker as required."*

The sensitive curtain is called the *retina;* in its centre there is a circular depression called the *fovea centralis.* This pit and its immediate margin is also called the *yellow spot*, from its colour. In ordinary light this is in all respects by far the most discriminative part of the retina, and it alone gives distinct vision of an object. Near it, on the nasal side, the optic nerve enters the eye, and this point, not being sensitive to light, is called the *blind spot.*

The retina is an expansion of the optic nerve. Its essential constituents are certain minute cells of two kinds, called respectively rods and cones. The yellow spot consists mainly of cones closely packed together. In other parts the rods predominate. The number of cones decreases from the yellow spot to the margin of the retina.

§ 4. *Descriptive Analysis of Light-Sensations.*—We must distinguish between neutral tints and colours proper. Neutral tints consist of black and white and intermediate greys. Starting with pure black, we can arrange the greys in a series, so as to pass by gradual transitions to pure white. Each grey may be interposed between two others which it resembles so closely as to be barely distinguishable from them. It differs from the one which precedes it in being a little lighter, and from the one which follows it in being a little darker. Thus, though the greys differ, the general form of transition between them is throughout identical.

The eye is capable of distinguishing about 700 shades of grey, from the deepest black to the most brilliant white. It should be noted that though black is not due

* Cleland, *Evolution, Expression, and Sensation*, pp. 77, 78.

to a positive physical stimulus, as other visual sensations are, it is yet a positive experience. The eye which sees darkness is not at all comparable with the back of the hand, which sees nothing. There is reason for believing that the grey field which is present to consciousness in the absence of light is due directly to a brain-process, and does not involve excitation of retinal elements at all.

Differences of colour-tone, apart from differences of saturation and intensity, are best studied in the order in which they occur in the spectrum. The spectrum is formed by passing ordinary white light through a prism, and so breaking it up into its component simple lights, and projecting these on a screen. The simple components of the white light are then arranged in a series in the order of their wave-lengths. At one end are the longest wave-lengths, giving the sensation of red, at the other the shortest, giving the sensation of violet, viz. a blue tinged with red. Between the red end and the violet end are interposed all the various colour-tones,* with the exception of the purples. The purples can be formed by intermixing red and violet lights in varying proportions. In what follows we shall suppose the spectrum completed by the addition of these purple tints, so as to form a closed figure.

We have said that colours are best studied in the *order* in which they occur in the spectrum. But unfortunately the spectrum is unsuitable in other respects for the analytic comparison of colour-tones. In comparing a series of colours merely with reference to their colour-tones, their brightness and saturation ought to be kept as uniform as possible. But the colours of the spectrum differ greatly in brightness. Hence in what follows we shall suppose a series of colours arranged in the order of the spectrum, but uniform in

* Not of course all degrees of saturation and intensity.

brightness and saturation. Such a series may be made by taking bits of transparent coloured paper, and adjusting their degree of brightness and saturation by placing bits of grey or white paper underneath them.

The whole series of colour-tones, beginning with red and returning to red, is continuously graduated, like the grey series of which we have just spoken. But there is an important difference. In the region of greatest wave-lengths, the transitions are from red to yellow; each member of the series is interposed between two others which it resembles so closely that the difference is barely perceptible, but it differs from the one in being redder, and from the other in being yellower. Thus the form of transition in the series is uniform throughout, and

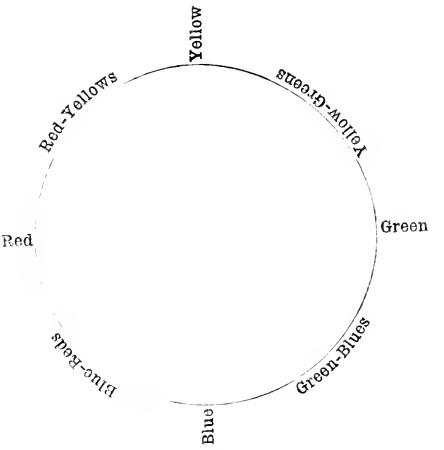

Fig. 2.—Circle illustrating serial order of colour-tones.

is quite analogous to that between black and white. But after passing yellow, there occurs what may be best

described as a change of direction. The transition is still continuous; but it now takes place between yellow and green. We begin with greenish yellows, and pass by the smallest perceptible transitions to yellowish greens, and so to pure green. After passing green there is another change of direction; we now have a green-blue series. There is still another turning-point after passing blue; the series which follows is blue-red, passing from blue through violet and purple to red. The change of colour in the spectrum is throughout so continuous that it is not possible to fix the exact point at which these changes of direction begin. All that can be said is that they begin somewhere in the region of red, yellow, green, and blue, respectively. Since the change of direction occurs, it must occur somewhere. At the precise point of its occurrence, there must be a simple colour-tone, such as pure red, pure yellow, pure green, or pure blue. For instance, pure yellow is the point of transition between the red-yellows and the green-yellows, and pure red is the point of transition between the purples and the red-yellows.

It may be well to note here a question of some psychological interest which has been much discussed. Is it right to say that a blue-green is a combination of blue and green, or a red-yellow a combination of red and yellow? It has become the fashion of late to say that such a colour as a blue-green merely resembles blue and green, but does not contain them as constituent elements. The colour itself, it is maintained, is perfectly simple. Now it is natural for common sense to distinguish one blue-green from another, by saying that there is more or less of blue in it, or more or less of green in it. It does not appear to the present writer that any cogent arguments have been brought

forward to show that this point of view is untenable. A blue-green may approach so very near to pure green as to be barely distinguishable from it, so that the casual observer would regard it as a pure green. It seems strange to say that such a blue-green contains no green at all. What is probably in the mind of those who deny the combination is that a blue-green cannot be simply defined as blue+green. The components by entering into so intimate a combination are modified in a peculiar way. This modification is a new element which may be regarded as simple. The experience of the combination of blue and green is a simple experience, and seems to be identical in kind with the experience of the combination of yellow and red, and other such pairs. But the components abstractly regarded are not the less* discernible as partaking of the nature of blue and green. Because there is something new and simple in the experience, we have no right to infer that there is no complexity in it. It must, however, be admitted that the question is not an easy one; and the balance of authority seems to be against the view which I am inclined to favour. But in any case it is most convenient to speak of such a colour as blue-green as a combination of blue and green. If the student is not inclined to believe that the colour actually is complex he may interpret the statement that blue-green is a combination of blue and green as merely meaning that on the one hand it resembles blue, and on the other resembles green.

* Of course they are not *separable*, but they are under appropriate conditions *distinguishable*. The respect in which blue and blue-green are seen to resemble each other when compared is different from the respect in which green and blue-green resemble each other when compared. This appears to me a sufficient reason for inferring complexity in the blue-green.

So far we have only considered difference in colour-tone, apart from difference in intensity and saturation; but all the colours of the spectrum may vary in either of these respects so as to form a continuous series. Each of them may be made more or less pale by an admixture of white light. If the general intensity of the illumination be increased or diminished while the spectrum is being examined, and if the increase or diminution is not too great, the result is that all the colours in the spectrum vary in brightness while remaining the same in colour-tone. But the change in brightness is in general accompanied by a change in saturation. Increased brightness makes a colour paler, and decreased brightness makes it darker—causes it to be mixed with black. When the increase or decrease is made sufficiently great, the colour-tones tend to disappear in mere whiteness or blackness, respectively. They may be mixed with white light, and also lowered or increased in intensity, so that both changes are combined. All the colour-differences recognised in ordinary life may be accounted for in these various ways. They are constituted by differences in primary colour tone, in intensity, and in saturation. Pink and rose-colour are whitish reds; maroon is a dark red, *i.e.*, a red so diminished in intensity as to be strongly infused with black. Olive is a dark green. We usually call a pale green or blue a light green or blue. The series of colour-modifications obtained by making a colour-tone, such as blue, paler or darker is psychologically quite analogous to to such a series as that of the blue-greens. Here, too, the question of simplicity or complexity arises. Those who maintain that no two distinguishable parts of the blue-green series have, *qua* sensations, any common element, but that they are all simple and independent colour-qualities,

must maintain the same for the blue-black series. They must maintain that a black in which only the artist's eye detects a tinge of blue has no element in common with pure black, or with black that has a barely appreciable tinge of green.

Intensity is by no means independent of colour. In the spectrum, the physical light is most intense in the region of red. But for our experience the yellow is distinctly the brightest colour. The blue is less bright than the red, but the difference is by no means in proportion to the difference in the intensity of the illumination.

It should be noted that the red of the spectrum is not pure red, but, as Hering pointed out, is tinged with yellow.

§ 5. *The Retina's own Light.*—In the total and continued absence of external light, there still exists a field of view which does not consist of mere darkness. Upon a background of medium grey, there are seen specks and clouds of colour. This is due to the fact that retinal elements are continually being stimulated by such internal processes as the circulation of the blood and the re-distribution of heat. This internal stimulation is called the *retina's own light* (*Eigenlicht der Retina*). The sensation of black is not obtained in its purest form in the complete absence of external stimulation. It arises when the eye passes from objects which stimulate it, to some object which fails to stimulate it except in a slight degree.

§ 6. *Total Colour-Blindness.*—The extreme margin of the retina is totally colour-blind. Let the eye be fixed upon an object immediately in front of it, and let someone gradually introduce an unknown coloured object into the field of view from one side. On its first entrance into the field of view, the object will appear white, grey, or black. Its

colour will only become recognisable as it approaches the centre of the field.

Again, when the illumination is sufficiently faint, the whole of the retina, with the exception of the yellow spot, is totally colour-blind. All the colours of the spectrum pass into grey when the light is made dim enough. When we pass from ordinary daylight into a dark room, we are not at first able to discern objects: but after a time the eye adapts itself to the faint illumination. It then becomes able to discern objects but not their colour-tones. It sees everything in black and white. It has been experimentally ascertained that this twilight vision depends on the portions of the retina which surround the yellow spot. The yellow spot itself does not become adapted to the faint illumination. If a small patch of colour is seen only by means of the yellow spot, decreasing illumination causes the colour to disappear altogether, but does not transform it into a patch of grey. Cases have been carefully examined and recorded of persons who showed an entire want of sensibility to colour-tones, not only under faint illumination, but under all conditions. They saw everything in black and white. In most of these pathological cases, though not in all, there is an alteration in the distribution of the intensity of light-sensation in the spectrum. For the normal eye the region of greatest brightness is that of yellow light; for the totally colour-blind, it lies in the green rather than in the yellow portion of the spectrum. It is a notable fact that the spectrum, as seen under sufficiently faint illumination, shows the same change in the distribution of the brightness of its parts. The totally colour-blind cannot for the most part bear illumination of ordinary strength. They can see well in a dim light, but are painfully dazzled

by full light. This indicates that their ordinary condition is analogous to that of a normal person whose eyes have been adapted to twilight vision. Colour-blindness is common to both cases. Probably a special visual apparatus is brought into play in twilight vision, and this is the only apparatus which in most cases exists in the eyes of the totally colour-blind. Recent research seems to show that this special apparatus is constituted by the rods of the retina as distinguished from the cones.

§ 7. *Partial Colour-Blindness.*—Between the outer margin of the retina and the yellow spot, there is a region which is partially colour-blind. It is sensitive to blue and yellow, but not to red and green. This may be tested by an experiment similar to that described in the previous section. When the colours of the spectrum are seen sideways, so that they fall on the partially colour-blind zone of the retina, the blue-green region appears grey. This grey divides the whole spectrum into two parts. The part containing light of greater wave-length appears yellow, that containing light of smaller wave-length, appears blue. Red and green are not discernible.

It is well known that there are many persons whose whole retina is affected by a partial colour-blindness, consisting in an inability to distinguish between red and green. Now, abstractly considered, this inability to distinguish between red and green may arise in either of two ways. A person who was insensitive to both red and green could not of course distinguish them from each other. But the same might hold true of a person sensitive to red and not to green, or to green and not to red. If we suppose yellow to be due to a combination of the retinal processes which are produced by red light and green light respectively, persons insensitive to red would

see all yellows as green, and those insensitive to green would see all yellows as red. Both modes of explaining partial colour-blindness have been, and still are, advocated. On the whole, it seems most probable that in the partially colour-blind the retina is equally incapable of giving rise to sensations either of red or green. But the question is full of difficulty. The evidence shows clearly that there are two distinct types of partial colour-blindness, and it has been maintained that in the one type the sensation *red* is absent and in the other type the sensation *green*. But instances have occurred in which only one eye has been colour-blind, the other eye being normal. These instances have belonged to the type which would be classed as *red-blindness* by those who distinguish between red-blindness and green-blindness. Now in such cases the colour-blind themselves testify that the colours they see with the abnormal eye are yellow and blue, and those they fail to see, red and green. They see the spectrum as composed of yellow and blue, with a grey region in which normal persons see blue-green.

If we suppose that partial colour-blindness consists in the absence of the sensations both of red and green, we must find some explanation of the difference between the two types which are on the opposite view distinguished as red-blindness and green-blindness. In both types it is possible, by mixing in varying proportions light from the short-waved end of the spectrum with light from the long-waved end, to produce all the colour-tones which they are capable of seeing when their retina is affected by intermediate simple lights. In type i. (the so-called red-blind), the rays at the extreme end of the spectrum, which give distinct sensations of red to the normal eye, produce no appreciable effect of any kind, and other reddish rays

produce only faint sensations. In type ii., the retina is sensitive in some way to rays at the red end of the spectrum; and in general, reddish rays produce more intense sensation of some kind than in type i. In comparing a certain reddish yellow with a yellow almost free from red, the intensity of the reddish yellow light must be made about four times as great for type i. as for type ii., in order that the resulting sensations may be indistinguishable in intensity and colour-tone. Clearly there is a great difference in sensitiveness to red light in the two types. But it by no means follows that the red light produces the sensation *red* in type ii. and not in type i. The most probable explanation is that the red light has a greater power of producing the sensation *yellow* in type ii. than in type i.*

A corresponding difference is found in normal persons in regard to sensations of yellow. "If by means of a special arrangement we bring a certain amount of the red part of the spectrum and a certain amount of the green part of the spectrum on to the eye at the same time, the result is a sensation of yellow. . . . By the same arrangement we can bring on to the eye at the same time a certain amount of the actual yellow of the spectrum. In this way we can make a match between a mixture of spectral red and green, on the one hand, and spectral yellow on the other, comparing the mixed† sensation derived from two parts of the spectrum with the sensation derived from a single (yellow) part. We have to adjust the quantities of red light and green light until the mixture seems of the

* Professor G. E. Müller has given an elaborate explanation of how this takes place. See *Zeitschrift f. Psychologie und Physiologie der Sinnesorgane*, Band XIV. Heft 3 und 4, p. 182.

† The sensation as distinguished from the stimulus is not mixed. Physiologists are apt to confuse the two things.

same hue and the same brightness as the yellow, not shewing either a reddish or a greenish tone. When this is done it is found that different people differ very materially as to the proportion of red and green, the proportion of the intensities of the two lights, necessary to make the match with yellow."*

§ 8. *Effects of the Mixture of Lights of Different Wave-Lengths.*—When lights of all wave-lengths are intermingled in due proportion, the result is grey or white. If in the mixture there is a relative predominance of some one light, such as green or blue, the result is a whitish green or a whitish blue.

If we select any colour of the spectrum, it is possible to find some other colour which, mingled with it in due proportion, will yield a neutral tint. If one of the components of the mixture is present in greater quantity than is required to produce a grey, the predominant light gives its own colour to the mixture. The other light diminishes the degree of saturation. Thus, if golden yellow and blue be mixed in proper proportions, they yield the sensation of white. As the proportion of blue is increased, the white becomes more and more a bluish white; as the proportion of yellow is increased, the white becomes more and more a yellowish white. Colours which, intermixed with each other, yield white, are called complementary. Yellow is complementary to blue. The red of the spectrum is not complementary to green, but to a bluish green. It should be remembered, however, that the red of the spectrum is not pure red, but yellowish. As every discernible colour of the spectrum possesses its complement, either within the spectrum or in the purple series, the pairs of complementary colours are indefinitely numerous. If the simple lights

* Foster, *Text-Book of Physiology*, part iv., pp. 1240-1241.

corresponding to colours which are not too far removed from each other in the spectrum are mingled, the result is a colour corresponding to an intermediate light. The wider the interval separating the mingled colours the whiter is the resulting colour. When the interval becomes sufficiently wide, mixture in proper proportion yields pure white. For instance, by mingling the simple lights which severally produce blue and green, we can obtain all the blue-greens. A larger proportion of the blue light yields a bluer green: a larger proportion of the green light yields a greener blue. If we mix blue with yellowish-green, we obtain a green mingled with the white due to the combination of blue and yellow. This green may be relatively pure or it may be bluish or yellowish according to the proportion of blue or yellow light in the mixture. The combination of of pure blue with pure yellow yields white. If, proceeding further, we mix blue with red, we obtain a new colour not contained in the spectrum,—purple. By mixing the red light of the spectrum with the green in certain proportions we produce yellow: by increasing the quantity of red light, the yellow is made redder; by increasing the quantity of green light, the yellow is made greener. The laws of combination which hold good of simple lights apply also to those mixtures which produce the same colours as the simple lights.

If we select three colours so related that by combining any two of them we can obtain a colour which is complementary to the third, it is possible, by varying combinations of the three, to produce all the colours of the spectrum. But there is only one triplet of colours by which the rest can be produced in a high degree of saturation. This triplet is red, green, and a bluish violet. For this

reason red, green, and violet, have been called primary colours.

The best method of mixing lights of different wave-lengths, so as to ascertain the resulting sensation, is to allow two different parts of the spectrum to fall on the same part of the retina at the same time. Another way is by using the colour-wheel or colour-top. Sectors of the colours to be investigated are placed on a disk. The pigments used in colouring must be as pure as possible; in other words, they must as nearly as possible reflect simple and not compound lights.* The disk is set rapidly spinning so that one kind of light is brought to bear on the retina before the effect of the other has ceased. Thus the different modes of stimulation are superposed. If one sector of the disk is blue, and another yellow, and if the colours are present in due proportion, the rapidly rotating disk will appear grey.

§ 9. *The Effects of Contrast.*—A man passing a street-lamp in moonlight casts two shadows. That which is cut off from the light of the lamp and only illuminated by the moon, appears blue. Now, moonlight is white or nearly so. The blue appearance of the shadow is due to contrast with the yellow illumination thrown by the lamp on the surrounding field of view. The excitement of the retina by the yellow light indirectly affects that portion of the retina or of the central nervous matter which is not directly excited by it. The influence thus exerted by the yellow light produces an effect similar to that which would be produced by a blue light acting directly. Now blue is complementary to yellow. The general law of contrast is that a colour in any part of the field of view tends to tinge adjoining parts

* The mixture of the pigments themselves, in the way that artists mix them, is by no means equivalent to a mixture of the lights which they reflect.

with its complementary colour. The effect is greatest when a large field of uniform colour acts on a small one. A small spot of grey on a relatively extensive field of blue, appears distinctly yellowish. If a small spot of red be substituted for the grey, it will combine its own colour with the contrast colour. It will appear yellowish red or reddish yellow. The effect of contrast is most marked at the meeting-point of the two colours. It is interfered with by lines of demarcation separating them, such as a pencil-mark drawn round the red spot on the blue field. It is also interfered with by differences in the texture of the coloured surfaces. For these reasons, it comes out most clearly when contours are obliterated, and differences of texture reduced to a minimum. The most favourable conditions are obtained in the case of coloured shadows, or by projecting the light from coloured glasses on a wall, or by means of coloured disks in rapid rotation with the colours in concentric zones. A simple method is to place a small piece of paper on a larger sheet, and to cover both with a sheet of tissue paper. The tissue paper obliterates contours and conceals difference of texture. The contrast effect is of course in general stronger in proportion as the direct excitation of the part of the retina affected by it is weaker; thus grey is better to experiment with than white. The influence of contrast is also operative between black and white. The same grey will appear darker on a white background, and lighter on a black background. If contrasted colours are complementary to each other, the contrast renders them more saturated.

§ 10. *The Negative After-Image, etc.*—"If, after looking steadfastly at a white patch on a black ground, the eye be turned to a white ground, a grey patch is seen for some little time. A black patch on a white ground similarly

gives rise when the eye is subsequently turned towards a grey ground," to the image of a white patch. These after-images, which follow the removal of the primary stimulation, are called *negative images*. "When a red patch is looked at, and the eye subsequently turned to a white or to a grey ground, the negative image is a greenish blue; that is to say, the colour of the negative image is complementary to that of the object. Thus also orange produces a blue, green a pink, yellow an indigo-blue, negative image, and so on."* The conditions for the production of the negative image are the more favourable, the more intense and persistent is the primary stimulation. When the primary stimulation is very transient, it may give rise in the first instance to a positive image, as we shall see later. Negative images arise also when the eye is simply closed after the primary stimulation as well as when it is turned to a different background.

It is not absolutely necessary for the occurrence of negative images that the primary stimulus should be removed. The same result may be brought about by diminishing its intensity. If we steadfastly gaze at a red spot on a yellow ground, and then diminish the intensity of the illumination by turning down the light or otherwise, a green spot upon a blue ground will appear instead of the red spot on a yellow ground.

The same process is manifested in a different way while the eye is actually subject to the primary stimulation in undiminished intensity. If we gaze long and steadfastly at any colour, it gradually becomes less saturated; the effect of steadfastly gazing at yellow is the same as that produced by gradually mingling the yellow light with more and more of its complementary blue. It becomes paler. We

* Foster, *Text-Book of Physiology*, part iv., book iii., chap. iii., p. 1266.

may gather these facts under one formula. The continuance of the same mode of stimulation tends to produce a contrast effect, not only on adjoining portions of the retina, but also on that portion which the stimulus directly excites. This contrast effect takes the form of a negative image when the primary stimulation is withdrawn or sufficiently weakened. When the stimulus is continued so as to maintain its positive effect, the contrast effect mingles with this, so as to produce loss of saturation. In this way, the yellow illumination of a gas-light or candle practically becomes equivalent to white light when it is long continued. It is noteworthy that negative images modify each other's colour-tone by contrast, and this even in cases in which it is difficult to obtain a contrast effect under ordinary conditions. The negative image of a red patch on a white ground is blue-green; the negative image of the white ground which surrounds it is reddened by contrast. This is important, because it shows that contrast phenomena are not due to errors of judgment, as has been maintained by Helmholtz.

§ 11. *The Positive After-Image, etc.*—Light acting on the retina takes a certain time to produce its full effect, and the retinal excitement takes a certain time to disappear after the stimulus has been removed. If we take a black disk with a white sector, and set it in very rapid rotation, the whole disk appears to the eye as a uniform grey. As the white sector is whirled round, it affects successive portions of the retina, but by no means so intensely as if it continued to act on the same part. Owing to the rapidity of the rotation, it returns again to the same point before the effect of the previous stimulation has become appreciably diminished. The result is a uniform grey identical with that which would be produced if the

white light from the sector were equally distributed over the whole surface of the rotating disk at rest. The persistence of the visual sensation after the stimulus has ceased gives rise, under certain conditions, to what is known as the *positive after-image*. To obtain this, the eye must briefly glance at an object, instead of steadfastly gazing at it. The conditions are most favourable when an eye which has for some time been withdrawn from the influence of light is momentarily exposed to a somewhat strong stimulus. "Thus if immediately on waking from sleep in the morning the eye be directed to a window for an instant and then closed, an image of the window with its bright panes and darker sashes, the various parts being of the same colour as the object, will remain for an appreciable time."*

§ 12. *Physiological Theories of Light-Sensation.*—Very little indeed is known by direct observation and experiment about the physiological processes either in the retina or in nervous matter corresponding to light-sensation. The theories on the subject are hypothetical constructions based on physical and psychological data. The two which are best known are those connected with the names of Helmholtz and of Hering respectively. Neither of these is satisfactory; but that of Hering is based on a more complete survey of facts; and if it is not right, it may safely be said to be on right lines. It has recently been greatly modified and improved by Prof. G. E. Müller, but his views are at once too complex and too recent for us to deal with them here. We shall therefore refer to Hering's theory mainly in its original form.

The theory of Helmholtz is primarily based on the facts of colour combination regarded from a physical point of view. The aim is to account in the simplest way for the

* Foster, *op. cit.*, p. 1265.

production of the same colour by many different combinations of physical light. Helmholtz believed that this could be done by assuming three, and only three, ultimate physiological processes. Each of these processes takes place in the first instance in the retina and is conveyed by its own special nerves to the brain, where it produces a corresponding specific nervous excitation. The processes severally correspond to the sensations of red, green, and blue. Their combination in equal proportions yields the sensation of white or grey. Every kind and combination of light excites all three processes. Hence no colour under ordinary conditions of stimulation is ever quite saturated. It always contains a certain intermixture of white. By combining in various proportions the red and the green processes, the green and the blue, the red and the blue, all the colours of the spectrum, together with the purple, may be obtained.

This theory seems a highly satisfactory account of the results of combining lights of different wave-lengths, so long as we do not test it by psychological analysis of the resulting sensations. But when we do this, a difficulty occurs in the case of white and yellow. By mixing green light with blue light, we obtain a blue-green. This, says Helmholtz, is due to a compounding of the physiological processes corresponding to blue and green respectively. His account of the matter is borne out by a scrutiny of the sensation itself. A blue-green partakes of the nature both of blue and green: it resembles both of them at once. It resembles each in varying degrees according as blue or green preponderates. But by mixing red and green lights we produce, not reddish green but yellow. The yellow does not partake of the nature both of red and green, as blue-green partakes of the nature both of green and blue. No

analytic scrutiny of sensation can discover such a colour as a reddish green. The same is true of white. White, according to Helmholtz, is a compound of all three ultimate physiological processes. But, as a matter of fact, the sensation of white does not partake at once of the three colour-tones, red, green, and blue.

Objections of this kind will probably have different weight with different persons. But it so happens that they are confirmed by some very important facts connected with colour-blindness. If white arises through a combination of the three elementary processes, all the colour sensations ought to be possible when the sensation of white is possible. But, as we have seen, there are well-established cases of total colour-blindness. Here all three elementary processes are absent, and yet the sensation of white remains unimpaired. On the theory of Helmholtz we must say that the three elementary processes are really present, but that they are on all occasions excited in equal proportions by all kinds of light. This is a rather improbable assumption, but the improbability becomes increased to the verge of impossibility, when we consider that the same hypothesis must be applied to a number of other cases in which colour-sensibility is absent, and sensibility to white and black is preserved. All lights of whatever wave-length, produce only neutral sensations, when they act on the retina for a very short time. All the colours of the spectrum pass into grey when the illumination is sufficiently diminished. They pass almost completely into white when the illumination is sufficiently intensified. The extreme outer margin of the retina is sensitive to white, but totally colour-blind. Under all these varying conditions we must, according to Helmholtz, suppose that the three elementary colour-processes are present, and that

the only reason why the corresponding colours are not perceived is that the processes are always excited in equal proportions.

An equally serious objection arises from cases of partial colour-blindness. It is evident that, if Helmholtz is right, the absence of one or more of the elementary colour-processes must involve the absence of the sensation of white, which is due to their combination in equal proportions. "A person who is green-blind ought, upon this supposition, to see in white only its red and blue constituents, and hence white ought to look to him as purple looks to us. As long as his defect made him incapable of explaining to us what he felt, this might perfectly well, for aught we knew, have been the case. But we know now that a person who is green-blind in one eye only sees white with his defective eye exactly the same as he sees it with his normal eye."* A similar argument applies also to yellow. The partially colour-blind usually retain the sensations of yellow and blue, although they are without the sensations of red or green or both. There is a marginal zone of the retina at which the sensibility to red and green ceases, and that to yellow and blue is retained. So, with great increase in the intensity of illumination, red and green are still discernible in the spectrum, though yellow and blue disappear. Such facts as these are incompatible with the supposition that yellow is due to a combination of the red process and the green process.

If the theory of Helmholtz is unsatisfactory in its account of colour-combination, its failure to explain other facts of light-sensation is still more conspicuous. It accounts for contrast effects between adjoining colours as errors of

* C. L. Franklin, "On Theories of Light-Sensation," *Mind*, N.S., vol. ii. (1893), p. 479.

judgment. A fuller investigation of these phenomena has shown that such an hypothesis is quite untenable. The colour-produced by contrast appears and behaves in all respects like the colour produced by direct stimulation. Negative images are explained by Helmholtz as due to fatigue. By long continuance, one or more of the ultimate colour-processes become exhausted, so that the others are predominantly aroused either by stimulation from without, or from the retina's own light. One objection to this view is that, on the principles of Helmholtz, fatigue of all three processes must be constantly taking place, as all three are excited by every kind of light. Now the fatigue which is to explain negative images must take place in the course of a few seconds. Hence we should expect a very conspicuous effect of fatigue from the ordinary use of the eyes in daylight. Hardly any capacity for light-sensations of any sort ought to be left at the end of an hour, especially after exposure to predominantly white light, which must exhaust all three processes equally.

In Hering's theory, a strenuous attempt is made to escape the difficulties which beset that of Helmholtz. Following the clue given by psychological analysis of light-sensations, he assumes six ultimate processes, corresponding to the sensations of white, black, red, green, yellow, and blue. These he arranges in antithetic pairs; white and black go together, and similarly red and green, blue and yellow. To each pair there corresponds a separate retinal substance, and a distinct modification of central nervous matter. The red-green substance is susceptible of two antagonistic processes, chemical in their nature. Red light excites the one, and green the other. When red and green light are combined in equal portions, neither process is produced because of their mutual incompatibility. Hence

there is no such colour as a reddish green. But both the red and green act on the black-white substance, so as to produce the sensation of white. When red or green sensations occur, their intensity is mainly due to this excitement of the black-white substance. Hence, when red and green light act simultaneously in equal proportions, though the two stimulations neutralise each other as far as their colour effect is concerned, they continue to act on the black-white substance, and produce the sensation of white. The relations of the blue and yellow processes are analogous. The black and white processes are supposed by Hering to be antagonistic in much the same way; but as a matter of fact there must be an essential difference here, as black and white combine to form intermediate greys, so that the two processes are not incompatible any more than the blue and green, or the yellow and red processes are.*

Hering is no doubt right in assuming that the processes corresponding to black, white, red, green, blue, and yellow, are separate and distinct in their nature, so that none of them can be resolved into combinations of the others. But he probably pushes this point too far in assuming that his pairs of antithetic processes always take place in separate substances. There is no doubt that there is a special apparatus connected exclusively with the white-black process. Total colour-blindness and allied facts seem to clench this conclusion. But it does not follow

* "Really, black and white do cancel each other in the retina: there is no grey process there. But the cortical cells with which the optic nerve is connected are always in a state of commotion (owing to changes of temperature, etc.), whether there is a stimulus before the eye or not; and this commotion gives us the 'intrinsic' or 'subjective' sight-sensation, the sensation of grey." Professor Titchener, *Primer of Psychology*, p. 12. (This proposed explanation is due to G. E. Müller, who works it out with great care.)

that the white-black processes cannot also take place in those retinal elements which subserve the colour processes. When blue and yellow lights act simultaneously so as to give rise to the sensation of white, Hering has good reason for denying that the blue process and the yellow process take place together. As such, they neutralize each other; but when he refers the conjoint effects of the two lights merely to their action on the white-black substance, his position is not without difficulty. Since the yellow and blue processes neutralise each other, the combined intensity of these processes must be deducted from the resulting sensation of white. This involves the assumption that the intensity of the yellow and blue processes, as such, is very small indeed, and that when they actually occur, the brightness of the corresponding sensations is mainly due to the intermixture of white. This is hard to believe. "Hopeless confusion is introduced into all our conceptions of colour when we are asked to believe that the entire brightness of every sensation of light is nothing but the brightness due to the white sensation which is mixed with it. . . . Can they be thinking beings who have allowed themselves to follow Hering into the intellectual vagary of supposing that a perfectly saturated red, for instance—that is a red wholly free from white admixture—no matter what the amount of chemical activity which called it forth, would have no brightness whatever, that there would be *nothing* in sensation corresponding to differences in amount of this photo-chemical process?"* Hering's view cannot be set aside in this sweeping way. But we can scarcely accept it without fuller evidence than has yet been adduced in its favour. If Hering is right in holding that brightness is almost entirely due to the effect which it produces

* Franklin, *op. cit.*, p. 480.

on his white-black substance, colours, which are indistinguishable in intensity and tone when the lights which produce them fall on the yellow spot, ought also to be indistinguishable when the lights which produce them fall on the totally colour-blind margin of the retina, and are seen as greys. As a matter of fact, this appears to be approximately true. On the other hand, two colours apparently identical in brightness and tone, one produced by a mixture of spectral lights, and the other by homogeneous light, may differ very greatly when they are seen as greys in twilight vision. But this can hardly form a cogent argument against Hering, because the conditions of twilight vision differ essentially from those of ordinary daylight vision. (See § 6, *ad fin.*)

The red and green of the spectrum in combination produce yellow. Hering accounts for this by the composite nature of the spectral red. It contains an admixture of yellow: and when the red and green lights neutralise each other, the yellow alone is left. He may be right, but this is one of the points on which it is difficult to see that his theory is quite satisfactory. It would in some respects be preferable to suppose that the yellow process* can be produced by positive co-operation of red and green lights.

Hering's theory may easily be made to account for the phenomena of contrast and negative images. They are due to a disturbance of the chemical equilibrium of the retinal substances. For instance, we may suppose that the white process has for its product the accumulation of material for the black process, and *vice versâ*. Hence the white process will positively tend to give rise to the black process, both in the portion of the

* *Viz.* a distinct retinal process corresponding to yellow, not a combination of the processes separately produced by red and green lights respectively.

retina affected and in the adjoining part. Whatever may be the special details of the process, it seems clear that both contrast effects and after-images are due to a positive tendency on the part of each of the ultimate retinal processes to produce its complementary process.

In conclusion, we may say that the theory of light-sensation, although beset with difficulties, is in a hopeful condition. New facts are being constantly discovered, and more exact quantitative measurements being made. New theories are being propounded, and old theories modified in accordance with these fresh discoveries, and, on the whole, satisfactory progress is being made. It is, above all, interesting to note that those attempts are most successful which follow most accurately psychological data and psychological analysis. In this respect, the comparison of the predominantly psychological method of Hering with the predominantly physical method of Helmholtz is instructive.*

* The general plan of exposition and much of the detail in this chapter is taken from Ebbinghaus, *Grundzüge der Psychologie*. Erster Halbband. Leipzig, 1897. p. 320 ff. The student who can read German should consult this work. In English the treatment of Light-Sensation in Foster's *Text-Book of Physiology*, fifth edition, book iii., chap. iii., pp. 1222-1247, is excellent. See also Mrs. C. L. Franklin's article "On Theories of Light-Sensation," *Mind*, N.S. vol. ii. (1893), pp. 473-489. The latest developments are mainly to be found in German and especially in the pages of the *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*, where the contributions of König, von Kries, and G. E. Müller are most important.

CHAPTER V.

SOUND-SENSATION.

§ 1. *Nature of the Stimulus.*—The physical stimulus which occasions sensations of sound consists of vibrations of the particles of the air. As in the case of light, we can distinguish wave-length or rapidity of vibration, amplitude, and complexity. Wave-length determines pitch; amplitude loudness, and complexity timbre.

§ 2. *Organ of Hearing.*—For anatomical details we must again refer to physiological text-books. The drum of the ear is thrown into vibration by impact of sound-waves. This produces movements in certain small bones, and these movements in their turn give an impulse to a fluid, which by its impact throws into vibration a membrane called the basilar membrane. The vibrations of this membrane are the immediate stimulus exciting certain hair-cells, in which the fibres of the auditory nerve terminate.

§ 3. *Noises and Musical Sounds.*—Noises as immediate experiences are characterised by confusion and indefinite complexity, and for the most part by irregularity. A musical sound is marked by unity and uniformity of character. "The vibrations which constitute a musical sound are repeated at regular intervals, and thus possess a marked periodicity or rhythm."* Musical sounds are also

* Foster, *Text-Book of Physiology*, book iii., chap. iv., p. 1361.

produced when the periodicity, instead of being regular, varies continuously. Regular vibrations which would otherwise produce musical sounds, give rise to noises, when a large number of them, differing but little in wave-length, occur together, as when a number of adjoining keys of a piano are simultaneously touched. But in general, the stimulus which gives rise to noises is produced by a series of vibrations differing from one another in period. "There is, however, no abrupt line between" noises and musical sounds. "Between a pure and simple musical sound produced by a series of vibrations, each of which has exactly the same period, and a harsh noise in which no consecutive vibrations are alike, there are numerous intermediate stages. Much irregularity may present itself in a series of sounds called music, and in some of the roughest noises the regular repetition of one or more vibrations may be easily recognised."*

§ 4. *Pitch.*—"The greater the number of consecutive vibrations which fall upon the ear in a second, the shorter the time of each vibration, the higher is the pitch. Hence the pitch of a sound is determined by the *length* of the wave, a low note having long, a high note short wave-length. We are able to distinguish a whole series of musical sounds of different pitch, from the lowest to the highest audible note."† In this series each note has its fixed position between two others which are barely distinguishable from it; the one being somewhat higher, and the other somewhat lower. The arrangement is therefore linear, and comparable to the series of greys intervening between white and black. It has been maintained that, as in the greys we can distinguish varying degrees of affinity to white and black respectively, so in the scale of notes of

* *Ibid.* † *Op. cit.*, p. 1362.

different pitch, two ultimate modes of sensation are involved, corresponding to black and white.* But this view has not been generally accepted.

"Vibrations having a recurrence below about thirty a second are unable to produce a sensation of sound."† There is a similar limit for high notes. For most persons this is fixed at about 16,000 vibrations a second, though some persons can distinguish tones of 40,000. In music, only a comparatively small portion of these tones are used, beginning with about thirty and ending with about 3,600 vibrations a second.

The power of distinguishing difference of pitch is very highly developed within a certain range. In tones rising from 100 to 1000 vibrations in a second, practised observers under favourable conditions can discriminate differences of pitch corresponding to differences of one quarter or one fifth of a wave-length. Tones above 4000 or below forty are distinguished from each other with great difficulty. Towards the higher end of the scale, differences of hundreds or even of thousands of vibrations a second may not be recognisable.

§ 5. *Harmonic Intervals.*—When, of two notes simultaneously produced, the vibration period of one is exactly twice as rapid as that of the other, the two sensations show a strong tendency to blend into one. It is hard to distinguish them as two. The result of their union is a richer and fuller sensation, peculiarly agreeable to the ear. There is also a tendency to confuse the two sensations even when they do not occur simultaneously. When even a practised musician is called upon to imitate on the piano a tone whistled by the mouth, he frequently produces the tone which corresponds to

* See Mach, *Analysis of the Sensations* (English trans.), pp. 127, 128.

† Foster, *op. cit.*, p. 1363.

half or double the number of vibrations per second, or in other words, the upper or lower octave of the note which he has to imitate. What is peculiarly interesting is that the tendency to confuse a note with its octave in memory, and to hear them as a single musical sound when they are simultaneously produced, does not depend on similarity in pitch. Notes much nearer in pitch are easily and clearly distinguished. What has been said of the octave holds also of other musical intervals, the double octave, the fifth, and the twelfth.

§ 6. *Combination of Musical Sounds from different sources.*— When musical sounds occur together, it usually requires attention to discriminate them. It is, as we have seen, peculiarly difficult to do so when the one is the octave, the fifth, or the twelfth of the other. The greater the relative intensity of one of the notes as compared with the others, the more easy it is to discern it as a separate tone. It is harder to distinguish in proportion to its relative faintness. The combination of tones yields a specific experience, which cannot be regarded as merely the sum of the separate experiences of the separate notes. Even when the constituent tones are discriminated, they are still apprehended as integral parts of a whole. This whole has its own characteristic pitch and its own characteristic intensity. Its pitch is approximately that of the lowest of its constituent tones, even when this is not the most intense. The intensity of the total experience is not equal to the sum of the intensities of its constituents. It is approximately equal to the intensity of the loudest among them.

§ 7. *Beats and Dissonance.*—"If two tuning-forks" sounded together "are not of the same pitch, but so related that the period of vibration of the one is not an exact

multiple of that of the other, the sensation which we experience has certain marked features. We hear a sound which is the effect on our ear of the compound wave formed out of the two waves; but the sound is not uniform in intensity. As we listen the sound is heard now to grow louder and then to grow fainter or even to die away, but soon to revive again, and once more to fall away, thus rising and falling at regular intervals, the rhythmic change being either from sound to actual silence or from a louder sound to a fainter one. Such variations of intensity are due to the fact that, owing to the difference of pitch, the vibratory impulses of the two sounds do not exactly correspond in time. Since the vibration period, the time during which a particle is making an excursion, moving a certain distance in one direction and then returning, is shorter in one sound than in the other, it is obvious that the vibrations belonging to one sound will, so to speak, get ahead of those belonging to the other: hence a time will come when, while the impulse of one sound is tending to drive a particle in one direction, say forwards, the impulse of the other sound is tending to drive the same particle in the other direction, *i.e.* backwards. The result is that the particle will not move, or will not move so much as if it were subject to one impulse only, still less to both impulses acting in the same direction; the vibrations of the particle will be stopped or lessened, and the sensation of sound to which its vibrations are giving rise will be wanting or diminished: the one sound has more or less completely neutralised or 'interfered' with the other, the crest of the wave of one sound has more or less coincided with the trough of the wave of the other sound. Conversely, at another time, the two impulses will be acting in the same direction on the same particle, the movements of the particle will be intensified, and the sound

will be augmented. And the one condition will pass gradually into the other. The repetitions of increased intensity thus brought about are spoken of as *beats*."* Beats are separately discernible when the difference between the vibration frequency of the concurrent tones is very small. As the difference becomes greater, the beats occur more rapidly, and are not so clearly discernible. They then give rise to a rattling or whirring effect. This ceases somewhere between thirty and sixty beats in the second. But even then the beats still manifest their presence by imparting to the notes which produce them a certain roughness. This experience may persist even when there are hundreds of beats in the second. When the beats occur with sufficient rapidity, the roughness or harshness ceases. Before this point is reached, the notes, because of their harsh effect, are said to be *dissonant*. The number of beats produced by two notes which approach each other in vibration frequency, is equal to the mathematical difference between the number of vibrations per second of each. "Thus two...tuning-forks vibrating respectively at sixty-four or seventy-two a second, will give eight beats a second,"† because the shorter wave overtakes the longer eight times, so as to give to the vibrating particles opposite impulses, which neutralise each other. We have seen that as the interval between the combined tones becomes increased, the beats become so rapid that they are no longer appreciable; but they recur again when the interval is sufficiently increased. They recur when the interval is somewhat greater or less than the octave, and again, when it is somewhat greater or less than the twelfth, the double octave, etc. Two tones of 200 and 396 vibrations in a second give four beats; four beats are also produced by

* *Op. cit.*, pp. 1367, 1368. † *Ibid.*

tones of 200 and 404 vibrations in a second. The number of beats is equal to the difference between the vibration number of the higher tone and that multiple of the vibration number of the lower tone which comes nearest to the vibration number of the higher tone. Thus if the notes are 200 and 596 the number of beats is $3 \times 200 - 596 = 4$. This explains why a small deviation from the octave or other musical interval produces a dissonant effect.

§ 8. *Difference-Tones.*—When two tones are sounded together, certain other tones are heard, occasionally with great distinctness, for which there is no assignable physical stimulus. Within the compass of the same octave, there are mainly two of these. One corresponds to the difference between the vibration numbers of the primary tones, and is called the *first* difference-tone. The other corresponds to the difference between the vibration number of the higher tone and twice the vibration number of the lower tone, and is called the *second* difference-tone. The mode in which these tones are produced has not yet been satisfactorily determined. But it seems that they are due to the structure and function of the organ of hearing, and not to physical conditions. Their explanation forms an important test for any general physiological theory of sound-sensations.

§ 9. *Timbre.*—The same note sounded on a piano, a violin, a trumpet, etc., has a very varying character, though its pitch is identified as the same. Differences of this kind are called differences of *timbre*. *Timbre* is due to the complexity of the sensation. Ordinary musical sounds, even when they arise from a single source, are not simple. Attentive analysis can discern a number of distinct partial tones. The power of discrimination varies with musical aptitude and practice in analysis. The pitch of the whole

complex is approximately the pitch of the lowest tone. This is called the *fundamental tone* and is of course identified at the outset. The *overtones*, as they are called, are separated from the fundamental tone by harmonic intervals. The most intense of them are usually those which have most affinity with the fundamental tones, such as the octave. Thus, though their relative intensity makes it easier to discriminate them, their harmonic relation makes it more difficult. With sufficient practice, a person of natural musical aptitude acquires great power of discriminating overtones. The less skilled may use artificial helps. Thus the partial tone may be first sounded separately on the key of a piano, and then kept in mind in attending to the note which is to be analysed. Several tones in succession may be tried in this way; some of them may be discernible as constituent overtones and others not. Sometimes slight differences in pitch are noted between the overtone and the corresponding note as sounded on the piano. This is one of the reasons why the analysis must be regarded as real, and not illusory.

A moderate number of relatively low partial tones makes the whole richer and fuller and somewhat higher in pitch. A large number of high overtones of considerable intensity gives to the whole a sharp and penetrating and sometimes a somewhat harsh character. The harshness arises from beats between the high overtones.

The combination of partial tones in a complex note produced from a single source is analogous to the combination of notes from different sources, except as regards the great difference in intensity between the fundamental tones and the overtones. The whole experience due to the combination is specific in its character, and is not a mere summation of the experiences severally due to the partial

tones. This is true even when the partial tones are discriminated. They are still apprehended as constituents of a whole having an unique character. Analytic attention in discovering overtones does not appear to create them in the moment of discovery, but to find what is already pre-existing. Thus the composition of an ordinary musical note affords an excellent example of sensations which are merely felt without discrimination of their distinctive qualities. So long and so far as the experience is unanalysed, the constituent sensations are present, *qua* sensations, though their presence is not cognised. There is a sense-differentiation without perceptual distinction.

§ 10. *General Theory of Sound-Sensation.*—Anatomical research seems to show that the immediate stimulus to the terminations of the auditory nerve is constituted by the vibrations of the basilar membrane. The main clue to the way in which this membrane acts is found in physical and psychological data. On the physical side, we have the broad fact that impulses which would separately give rise to distinct waves of sound, blend their effects before they reach the ear into a single resultant effect. They produce a single wave, the form of which is mathematically accounted for by their combination. This is true whether the several impulses come from separate material objects or from the same object. Thus the vibrations which produce ordinary sounds are complex in their mode of origin. The forms which they consequently assume can be mathematically resolved into a combination of the forms of certain constituent simple waves. These simple waves are called *pendular*, because their form is like that described by the sweep of a pendulum. Though one, not many waves, is produced by the impulses which simultaneously set the air in vibration,

yet each of these impulses acts separately on the organ of hearing. This is known to be so because the several sensations corresponding to each are distinguishable in consciousness. We can analyse a single note into its partial tones, and we can distinguish a number of notes sounded simultaneously from different sources. This is the starting-point for the theory of sound-sensations. The organ of hearing must be so constructed as to respond separately to the several impulses which produce the complex wave.

The most simple and obvious, if not the only, way of accounting for this analytic power of the ear is that propounded by Helmholtz, and now commonly, though not universally, accepted. It proceeds on the analogy of certain physical phenomena. If a tuning-fork, which produces a simple tone without overtones, be laid on the top of a piano, and if the corresponding note is sounded by touching one of the keys, the tuning-fork vibrates in sympathy with it. If the lower octave of the note be sounded, the tuning-fork again vibrates in sympathy; for its own note, being an octave of the note sounded on the piano, is contained in this as one of its overtones. It can be similarly made to vibrate in sympathy with any of the notes which contain its own note as an overtone. It is unaffected by other notes. Conversely, if the tuning-fork is struck in the neighbourhood of the wires of a piano, those wires will vibrate in response to it, which are specially adjusted to the same tone, or to any of the notes which contain this as an overtone. In the second case they do not vibrate along their whole length, but in segments. The wire which corresponds to the lower octave of the tone sounded on the tuning-fork responds by a vibration of which the wave-length is half the length of

the wire. Now, the theory of Helmholtz is that the basilar membrane consists of a series of strands, each of which, like the wires of a piano or like a tuning-fork, is adapted to its own peculiar tone, and vibrates in response to this. Thus, however complex the physical sound-wave may be, it produces in the basilar membrane not a single complex vibration, but a number of distinct vibrations, and each of these constitutes a separate stimulus affecting the terminations of the auditory nerve.

Though the theory of Helmholtz is very simple and plausible, it is not without difficulty. In particular, it does not in its present form satisfactorily explain difference-tones (see § 8). Attempts have been made to find a substitute for it: but in all probability it only needs modification and development. Recently facts have come to light analogous to colour-blindness which appear strongly to support it. There are cases in which the mechanism for conducting sound-impulses is intact, and yet the sensibility for greater or smaller portions of the scale of tones is absent or much impaired. In some instances the tone-deafness extends to the greater part of the scale, leaving sensibility only to a fragmentary portion of it. One tone of moderate intensity may be clearly distinguished, while another neighbouring tone is indistinguishable, even when it is very loud. It is difficult to explain these phenomena unless we suppose in the ear a system of separate elements, each adjusted to its own peculiar tone, some of which may be absent or incapable of discharging their function while the rest behave in a normal manner.

In this chapter I have followed Ebbinghaus very closely. For further reading in English the student is referred to Foster's *Text-Book of Physiology*, part iv., book iii., pp. 1361-1378, and to *The Power of Sound*, by E. Gurney. In German there is the great work of Karl Stumpf in two vols., entitled *Tonpsychologie*.

CHAPTER VI.

OTHER SENSATIONS.

§ 1. *Taste and Smell.**—The greater number of the sensations which are usually ascribed to taste are in reality odours. "If the nose be held and the eyes shut, it is very difficult to distinguish, in eating, between an apple, an onion, and a potato; the three may be recognised by their texture, but not by their taste." Cinnamon applied to the tongue under the same conditions appears like flour; the taste may appreciate a slight sweetness, but that is all. There are four undoubted taste-sensations—sweet, salt, acid, and bitter. There are two others—the alkaline and the metallic—which are disputed. The alkaline is possibly a mixture of salt and sweet, together with peculiar touch-sensations.

All taste-sensations appear to be intermingled with and qualified by tactile sensations. An acid, too slight to be distinguished as such, produces a peculiar touch-sensation by its astringent character; and as the acidity is increased the touch-sensation becomes stinging, and finally passes into a pain-sensation which completely dominates the special experience of acidity. Salt is also accompanied by a stinging sensation: but this does not reach the same pitch of intensity as in the case of acids. The sensation of

* In regard to taste, I have mainly followed Kiesow, "Beiträge zur Physiologischen Psychologie des Geschmacksinnes," *Philosophische Studien*, X. (1894), pp. 329-368, 532-561.

softness and smoothness is associated with sweetness; this is appreciable when the sweet substance is present in quantities so small that it cannot be discerned as such. As the sensation of sweetness becomes intensified, the touch-sensation is dominated and obscured by it. But it emerges again as the sweetness is further increased. Very intense sensations of sweetness are sometimes accompanied by a biting sensation.

The tip of the tongue is especially sensitive to sweetness, the edges to acidity, and the base to bitterness. The tip and edges are equally sensitive to salts, the base less so. When the mouth has been washed out, and some neutral substance, such as distilled water, is applied to the tongue, the result differs according to the point of application, and varies in different persons. The base of the tongue appears in all cases to respond by a sensation of bitter. In some persons the same sensation is aroused to whatever part of the tongue the distilled water is applied. Others feel no sensation except at the base. Others feel a sensation of sweetness at the tips and of acidity at the edges. There appear to exist among taste-sensations relations somewhat analogous to the contrast of colours. Salt, by a sort of contrast, makes distilled water taste sweet. It has the same effect on solutions of sweet substances which in themselves would be too weak to be appreciable. It also has an intensifying effect on solutions which are strong enough to be appreciable. It operates in this way both when the same part of the tongue is successively stimulated, first by a salt, then by a neutral or sweet fluid, and also when the salt and the sweet are simultaneously applied to homologous parts of the tongue, *e.g.*, to corresponding points on the right and left edges of the tongue. Sweet has a much weaker contrast effect on salt, than salt on sweet. In both

forms of the experiment, sweet instead of making distilled water taste salt by contrast, makes it taste sweet. On the other hand, contrast with sweet makes distinctly appreciable a salt solution in itself too weak to be perceived. Similar relations have been observed between salt and acid, and between sweet and acid; but in the case of sweet and acid they are manifested only when the two stimuli are applied successively to the same part of the tongue, not when they are applied simultaneously to homologous parts. Bitter appears neither to produce contrast effects nor to be affected by them.

The sense of taste can be stimulated only by fluids. Solid substances must be dissolved in the mouth before they can affect it.

The appropriate stimulus for the sense of smell, on the other hand, consists of odoriferous particles conveyed to the membrane in a gaseous medium. The sensations of smell have not been adequately classified or analysed into their primary constituents: there appears to be a very great variety of them. They are often modified by mixture with touch and taste-sensations. The pungency of an odour is not strictly a sensation of smell at all, but a peculiar kind of tactual experience. Odours proper do not appear to produce sneezing: this is due to irritation affecting the sense of touch. Odorous sensations take "some time to develop after the contact of the stimulus with the olfactory membrane, and may last very long. When the stimulus is repeated the sensation very soon dies out: the sensory terminal organs speedily become exhausted. The larger, apparently, the surface of olfactory membrane employed, the more intense the sensation; animals with acute scent have a proportionately large area of olfactory membrane. The greater the

quantity of odoriferous material brought to the membrane, the more intense the sensation up to a certain limit; and an olfactometer for measuring olfactory sensations has been constructed, the measurements being given by the size of the superficial area, impregnated with an odoriferous substance, over which the air must pass in order to give rise to a distinct sensation. The limit of increase of sensation, however, is soon reached, a minute quantity producing the maximum of sensation, and further increase giving rise to exhaustion. The minimum quantity of material required to produce an olfactory sensation may be in some cases, as in that of musk, almost immeasurably small."*

The sense of smell plays an immensely important part in the life of animals. It is to them what sight and hearing are to us. The animal detects its prey and follows it by means of scent. On the other hand the scent of the pursuer warns the prey and guides its efforts to escape. Probably every individual and every species has its own characteristic and distinctive odour. There are some men who can distinguish human beings by smell; dogs and other animals possess this power in a very high degree. The ants of one nest attack those of another nest or of another species who may intrude among them; whereas they never under normal conditions attack ants belonging to their own nests. It has been clearly shown by experiment that this is due to the peculiar and distinctive odours belonging to different nests and their inhabitants. The unfamiliar odour of an ant coming from a strange nest has an exasperating effect. The intruder is attacked and usually killed. If before being introduced into a nest it is first bathed in juice produced by crushing the

* Foster, *op. cit.*, pp. 1389-1390.

tenants of the nest, no notice is taken of it however widely it may differ in appearance from these. It is incorrect to say that ants *recognise* other ants as belonging or not belonging to their own family: all depends on the irritating effect of the unfamiliar odour of strangers.* The comparatively small part played by smell in the mental life of human beings may be accounted for by the fact that trains of ideas constitute so large a part of human experience. Smells are not adapted to ideal revival in serial succession as sounds and sights are.

§ 2. *Cutaneous Sensations.*—These are principally of three kinds—pressure, temperature, and certain others allied in their nature to organic sensations, among which the most prominent are those which from their peculiarly disagreeable character are called *pains*. This last class will be best considered in connexion with organic sensations in general.

"The sensation caused by *pressure* is at its maximum soon after its beginning, and thenceforward diminishes. The more suddenly the pressure is increased, the greater the sensation; and if the increase be sufficiently gradual, even very great pressure may be applied without giving rise to any sensation. A sensation in any spot is increased when the surrounding areas of skin are not subject to pressure at the same time. Thus if the finger be dipped into mercury the pressure of the mercury will be felt more at the surface of the fluid adjoining the skin which is not in contact with the mercury, than in the parts of the skin wholly covered with the mercury; and if the finger be drawn up and down, the sensation caused will be that

* See Albrecht Bethe's *Dürfen wir den Ameisen und Bienen psychische Qualitäten zuschreiben* (*Archiv für die gesammte Physiologie*, Bd. 70). Bethe also shows that ants find their way to and from their nests by means of smell. In moving they leave an odorous track behind them.

of a ring moving along the finger."* It should be noted that this applies only to sensations of pressure sufficiently marked to attract attention. As a matter of fact, pressure-sensations are present over the general surface of the body in every moment of our lives, and their presence can be detected as soon as we turn attention to them. Such conditions as the circulation of the blood, etc., furnish a constantly present stimulus within the body itself, and such uniform contact as that with the clothes we wear produces sensations which ordinarily escape notice, but are quite discernible when we attend to them.

The different areas of the skin are sensitive to pressure in varying degrees. The tips of the fingers, the lips, and the surface of the forehead, discriminate the smallest differences. The sole of the foot, the arm, and the back, have comparatively little power of discrimination.

Bodies of the same shape, weight, size, and temperature, produce different pressure-sensations according to their various textures. Thus contact with a smooth surface and contact with a rough surface yield specifically different experiences. Similarly, we distinguish sharpness and bluntness, hardness and softness, wetness and dryness. All these peculiar qualities of sensation are due to varying combinations of pressure, to variations in the relative intensity of the constituent pressures, in the mode of their spatial distribution, and in their successive changes. A smooth surface produces a uniform pressure at every point; a rough surface produces a pressure which is discontinuous and irregular. The difference between hard and soft is connected with successive changes in the intensity of the pressure sensations. Sharpness and bluntness are differences in the extent of surface touched. These various qualities are

* Foster, *op. cit.*, p. 1413.

presented to consciousness, not merely as varying combinations of pressure, but as having a specific character of their own, which does not appear to be capable of further analysis. We are here confronted with the same fact which has met us in other departments of sensation. Just as the partial tones combined in a musical note produce by their union a specific experience distinct from the quality of any of them taken separately, or of all of them taken together, so the combination of pressures which we experience when velvet comes in contact with the skin, produces those peculiar modifications of consciousness which we call softness and smoothness.

Temperature-sensations are of two classes—the cold and the hot. The sensation of cold is as specifically distinct from that of warmth, as the sensation of black from that of white. A sensation of heat sufficiently marked to attract attention seems only to take place when the temperature of a region of the skin, which has previously been fairly constant, is raised; and it is also a necessary condition that the rise in temperature should not be too gradual. "Our skin has a certain temperature which varies from time to time, according to circumstances, and is not the same in all regions of the skin at the same time. A given spot of skin at a given time will have a certain temperature; that temperature does not give rise to a distinct sensation though its effects may enter into what we may call general sensibility; we may not be directly conscious, for instance, that the forehead has one temperature and the hand another, though the two temperatures may differ widely."* As the stimulus for sensations of heat is a more or less sudden rise in the temperature of the skin; so the stimulus for sensations of

* *Op. cit.*, p. 1416.

cold is a more or less sudden fall in the temperature of the skin. This applies only to sensations conspicuous enough to attract attention. A general experience of heat or cold is always present, and discernible whenever we are interested in taking note of it.

The sensations of heat and of cold and of pressure respectively are produced at different points of the skin. "If a blunt pointed but otherwise fine needle be used to exert pressure, a little exploration will ascertain that at some points the amount of pressure can readily be recognised—the sense of touch is acute—while at other points, and these may be quite near the others, the amount of pressure cannot be recognised, and indeed no sensation is experienced until the pressure is excessive and then the sensation felt is not one of touch proper but of pain. Similarly, if heat or cold be applied by means of a metal tube or rod narrowed to a point, it will be found that some points of the skin are very sensitive to changes of temperature, while other points are insensitive to temperature, the application of heat or cold giving rise to pain only and not to specific sensations of heat or cold. Further, the points of the skin which are sensitive to pressure are those which are not sensitive to heat or cold, and *vice versâ*."* It appears also that the points sensitive to heat are not identical with those sensitive to cold. The separation in this case does not seem to be so complete as that between temperature-spots and pressure-spots. Some points peculiarly sensitive to cold seem also in a less degree to be sensitive to heat, though this result of experiment may be illusory. It is possibly due to spreading of the stimulation over neighbouring parts of the skin. Further investigation is

* *Op. cit.*, p. 1428, 1429.

needed, but the general result, so far, is: the skin is the seat of three distinct senses,—the sense of heat, the sense of cold, and the sense of pressure.

§ 3. *Motor Sensations.*—If we close our eyes so that we cannot see our own body, we are none the less distinctly and accurately aware of the position of our limbs. If we move a limb, for example the arm or the finger, we are distinctly and accurately aware of the amount and direction of the change and of the new position which it produces. Similarly, if instead of merely moving a limb we push against a wall, or lift a weight, we are aware of the kind and degree of tension produced by the resistance opposed to our efforts. If, instead of actively initiating movements ourselves, we allow the position of our limbs to be shifted in various ways by another person while we remain passive, we are still almost equally capable of appreciating position and change of position. If our muscles are contracted by the application of an electric current, the experiences which mark position and change of position as well as amount and kind of resistance, continue to be present.

How do these experiences originate? In any movement a great many changes take place in a great many tissues. In moving the arm, the skin is in various ways crumpled and pressed at every stage of the process. There are varying degrees and kinds of tension in the tendons: the joints slide over one another; the muscles pass through various stages of contraction. All these tissues appear to be supplied with sensory nerves; it is therefore possible that each and all of them contribute to determine the experiences which mark position and change of position. As a matter of fact, it is probable that all of them contribute in some degree. The skin appears to be the least important. Our discrimination of position, movement, etc.,

is not "notably diminished by temporary anaesthesia of the skin; if, for instance, the skin of the arm be rendered for a while anaesthetic, we do not find any marked change in our power of judging weights or resistance, or in appreciating, with the eyes shut, the position of the limb."* Joints, on the other hand, constitute a very important factor, so far at least as concerns appreciation of position and change of position. This is shown in a series of experiments carried out by Goldscheider. "This patient observer caused his fingers, arms, and legs to be passively rotated upon their various joints in a mechanical apparatus which registered both the velocity of movement impressed and the amount of angular rotation. No active muscular contraction took place. The minimal felt amounts of rotation were in all cases surprisingly small, being much less than a single angular degree in all the joints except those of the fingers."† Anaesthesia of the skin made no difference in the result. Anaesthesia of the joints themselves greatly decreased the power of discrimination. In the perception of resistance, the tendons are probably the most important factor. They are organs especially adapted for the appreciation of strain or tension. "Let your arm hang down loosely by your side. Attach a fairly heavy weight by a string to the forefinger. The weight pulls the surfaces of the elbow and other joints apart; so that there is no pressure or friction of one surface against another. But you soon get the sensation of strain throughout the arm."‡ Sensations due to the states of the muscles themselves undoubtedly seem to exist; but it is very difficult to estimate their importance, as marks of varying position, movement, and tension.

* *Op. cit.*, p. 1136. † James, *Principles of Psychology*, vol. ii., pp. 192-193.
‡ Titchener, *An Outline of Psychology*, p. 61.

The distinction between position-sensations and movement-sensations is important. The former are due to the particular form of the tension of the organs when quiescent, the latter to change in this form.

The sensations we have so far considered are peripheral in their origin. They are produced by impressions proceeding from outlying portions of the body to the nervous system. They are equally present when we move by our own volition, and when we allow our limbs to be moved by another person, or our muscles to be thrown into contraction by such artificial means as the electric current. But it has been maintained that besides these sensations due to the actual state and changes of state of muscles, joints, tendons, and skin, there is also a sensational experience, directly connected with the initiation of movement, with the discharge from the nervous centre independently of any effect produced by it on the muscles and the tissues connected with them. Thus, according to Bain, there is a direct sense of energy put forth which is independent of any results the putting forth of energy may produce. This peculiar modification of sensory consciousness has been called the *sense of effort*, or the *innervation-sense*. At the present time it is the fashion wholly to deny its existence. The denial is mainly founded on the fact that we can appreciate position, movement, and tension as well when the limbs are passively moved as when we move them by our own volition; and that, on the other hand, when in consequence of nervous diseases the sensibility of the joints, tendons, etc., is impaired or destroyed, there is a corresponding incapacity to appreciate position, movement, and tension. But this argument lacks logical cogency; for if there be an innervation-sense it cannot, from the nature of the case, inform us of the actual

effects of the motor impulse. It can only tell us what we are attempting to do, not what we are actually doing or have done. Thus a patient may will to move an anaesthetic limb with his eyes shut; and he may suppose that the movement has actually taken place, although the limb has all the time been held in its original position by another person. The patient does not know whether the limb has changed its position or not; but he none the less knows that he has made an attempt to change its position. Hence the argument does not positively disprove the existence of an innervation-sense. But it must be admitted that it throws the *onus probandi* on those who maintain this peculiar mode of sentience. We have said that the patient would in such a case be aware that he had made an attempt; but this only shows that he is conscious of his volitions. But volition is by no means the same as innervation-sense: it is not, in fact, a sensation at all, any more than a belief is a sensation; it is a peculiar mode of conation. It is true that in order to will a movement a person must in some way be able to think of this movement. But for this, ideal representation is enough: the ideal representation may involve ideal reproduction of motor sensations proper, or it may mainly consist of a visual image. In neither case can it be regarded as a peculiar sensation immediately accompanying the motor discharge.

There is certainly a vital difference between the experience of having a limb passively moved, and that of moving it by our own initiative. But it is very far from clear that the active movement involves a peculiar sensation which is absent in the passive movement, a sensation comparable with those which arise from joints and tendons. In passing from a state of doubt to a state of belief there is a

peculiar change in consciousness, but it is not a sensation. Similarly, in passing from a state of indecision to one of voluntary determination, there is also a change in consciousness; but it is in no way comparable to sensations such as those of redness or greenness, of heat or cold.

There are, however, certain facts which lend support to the assumption of an innervation-sense. The patient who attempts to move a paralysed limb not only knows that he is making the attempt, but is also aware of differences in the amount of effort which he puts forth. This may be explained, at least in part, by the fact that the motor impulse proceeds not only to the limb which is to be moved, but also to other parts of the body which preserve their sensibility, and especially to the organs of respiration. But, as Wundt insists, there are certain cases of paralysis of the muscles of the eye which are harder to deal with. If the muscle which moves the eye to the right is completely paralysed, so that an outward movement of the eye is no longer possible, the effort to move it produces an apparent movement of the object looked at. The muscle may be only partially disabled, so that it is still capable of a lateral rotation of twenty degrees and of no more. In this case, the patient, although he has moved his eye only through the angle of twenty degrees, refers the objects seen to the same position which they would occupy if they were seen by the normal eye turned as far as possible in an outward direction. This seems to show that the patient measures the amount of movement by the amount of his own effort, independently of any peripheral sensations which this effort may produce. It seems impossible to explain the illusion as due to sympathetic movements in the other eye: for when both eyes are open, either the illusion does not occur, or the two eyes see double, and the

illusion is confined to the image presented to the diseased eye. The illusion is constantly present when the normal eye is closed.

It seems that the case for innervation-sensations cannot be regarded as completely disproved by its opponents. It is probably best at present to suspend judgment and wait for further evidence. In conclusion, we must note one very important point. There are two forms of the theory, one advocated by Bain, and the other advocated by Wundt. According to Bain, the innervation-experience is primarily occasioned by the motor discharge itself: it is a unique kind of sensation correlated with the active initiation of movement. According to Wundt, on the contrary, its specific quality is ultimately derived from a peripheral source. The area of the cortex from which the motor impulses are discharged is also the area in which motor sensations in general are localised. Hence, the excitement of this area in the process of motor discharge involves a reproduction of experiences more or less similar to those which arise from peripheral sources in the actual execution of the movement; but the reproduction assumes the character rather of an actual sensation than of an idea.* There can be no doubt that, if we are to accept the theory of innervation-sensations at all, we must accept it in the form in which it is propounded by Wundt, and not in that which Bain has given it.

§ 4. *Organic Sensations.*—The sensations we have so far considered derive their main importance from the function they fulfil in the perception of external objects. Their specific qualities correspond not only to the specific modes in which the organism is affected, but also to the specific nature of the agencies which act upon it. It is true that

* On this point Wundt's own statements are somewhat vague.

motor sensations do not arise from external impressions: they originate within the organism itself. But they none the less play a most important part in the perception of external things. It is through them that we appreciate weight, resistance, and space-relations. But there is another class of sensations which mainly mark states of the organism itself, and not the nature of external objects. These are called *organic sensations*. Extreme heat and extreme cold no longer produce sensations distinctive of heat and cold at all; they both produce a peculiar painful experience, which is the same whether the external agency is heat or cold. In like manner, the sensations resulting from a bruise, a blow, or a cut, may be similar, though they are produced by very various external agencies. It is characteristic of such sensations that they persist often for a long time after the external agency has ceased to operate. The bodily change which it has produced continues to act as a persistent stimulus. A wound persists after the knife which has inflicted it is withdrawn, and along with the wound the sensation occasioned by it persists also. Organic experiences may arise either through the operation of an external agency, or merely through the changing states of the internal organs. Hunger and thirst and the like are familiar examples of sensations originating from within the organism itself. Motor experiences, as we have seen, generally mark the qualities and relations of external things; but the sensations of fatigue or of cramp are truly organic, because they mark the state of the muscular apparatus itself, and do not contribute to our knowledge of the external world. In every moment of our lives organic sensations constitute a most important element in our experience. The general tone of our bodily feeling depends on them. On them depends the difference between

feeling well and feeling ill, and the like. But this or that organic sensation does not attract attention and emerge clearly into consciousness, unless it attains a special pitch of intensity. In general, organic experiences from manifold sources are merged in a massive whole constituting what is called the *common sensibility* or *coenaesthesis*. When, from the general mass of common sensibility, a single organic sensation detaches itself and becomes salient in consciousness, it is usually intrusive and engrossing. Such sensations are specially characterised by their diffusiveness. They do not, like sensations of sight or pressure, depend merely on the localised affection of a circumscribed portion of the organism; they also involve a more or less widespread organic disturbance. For instance, the pain-sensation produced by a cut or a blow is a complex experience partly depending on the disturbance of respiration, circulation, and the whole motor apparatus of the body. The more intense the sensation, the more conspicuous and widespread is this general organic disturbance.

This brings us to another aspect of organic sensation. It may arise, and usually does arise in part, from a disturbance of the nervous system, which excites changes throughout the organism, these changes in their turn giving rise to sensations. In all the more intense emotions, there is an accompaniment of organic sensation originating in this manner. This is so important an element in the total state that it has been held to constitute the essential part of the emotional experience.

We have seen* that the possibility of central initiation makes organic sensations reproducible as no other sensations are under normal conditions. Whatever reinstates

* Book i., chap. ii., § 9, *ad fin.*

a similar nervous disturbance, will indirectly produce similar organic sensations. Tickling, for instance, is a very diffusive experience; and the mere anticipation will produce the corresponding organic sensations, because it produces the general disturbance of nervous equilibrium on which they depend. The uncomfortable feelings which arise in paying a visit to a dentist, even before he begins operations, have the same source.

We shall have something to say about pain-sensations in general in a subsequent chapter. We need here only refer to two organic experiences of special importance, hunger and thirst. Thirst is usually produced "by the diminution of the water present in the body either through restriction of the intake, or through excess of the output in the secretions, such as that of sweat, or through both together. . . . . Thirst thus brought about may be temporarily assuaged by simple moistening of the soft palate. From this we may infer that the sensation of thirst is brought about by afferent sensory impulses started in the mucous membrane of the soft palate by a deficiency of water in that membrane."* Hunger is usually "produced by the products of digestion ceasing to be thrown into the blood." The sensation seems "to be in some way specially connected with the condition of the gastric walls, much in the same way that thirst is specially connected with the palate; the products of digestion have a much greater power in appeasing hunger when they act locally and directly on the gastric membrane than when they are simply brought to bear on the body at large, and a small quantity of food will immediately satisfy hunger when introduced into the stomach, though it will have no effect when introduced otherwise."†

* Foster, *op. cit.*, p. 1423. † *Op. cit.*, p. 1424.

CHAPTER VII.

THE WEBER-FECHNER LAW.

§ 1. *The Experimental Facts.*—We can compare any two objects and pronounce them like or unlike. If the objects are disparate in kind, we are unable to say more than that they are unlike. This is the only result of comparing the brightness of the sun with the immortality of the soul. If we compare the brightness of a light with the loudness of a sound, we can say that both possess intensity; but we cannot fix any definite relation between them. For instance, we cannot affirm that the loudness of the sound is equal to the brightness of the light. On the other hand, if we compare the quantitative variations of the same kind of object in the same respect, we can pronounce more definite judgments. We can pronounce that one sound is less or more loud or equal in loudness to another. Besides this, we can compare degrees of unlikeness with definite results. We can say that one sound, C, is as much louder than B as B is louder than A. In this way we can select two sounds of different loudness, and then proceed to find a third exactly intermediate between them. We may then compare the intermediate sound, B, with each of the extremes, A and C, so as to interpose between A and B a D, unlike in loudness to A in the same degree in

which it is unlike in loudness to B; and to interpose between B and C an E unlike in loudness to B in the same degree in which it is unlike in loudness to C. It is thus possible to form a scale passing by equal gradations of unlikeness from a very faint sound to a very loud one. Similar scales can be formed for degrees of unlikeness in pitch, in the brightness of light, in weight as appreciated by pressure on the skin or by lifting, etc. Now the fundamental fact which underlies Weber's law is that equal degrees of unlikeness in sensation do not correspond to equal increase or decrease in the absolute intensity of the stimulus. If a series of increasing intensities of stimulation be denoted by R_1, R_2, R_3, R_4, and the corresponding sensations by r_1, r_2, r_3, r_4, the degree of unlikeness between r_1 and r_2 is equal to the degree of unlikeness between r_3 and r_4, when $\frac{R_1}{R_2} = \frac{R_3}{R_4}$, or to use an equivalent formula, in some respects more convenient, when $\frac{R_2 - R_1}{R_1} = \frac{R_4 - R_3}{R_3}$.

Long before quantitative methods in psychology were thought of, astronomers had occasion to classify the stars according to their relative brightness. The different classes are arranged in a scale. At the top of the scale comes the brightest; the unlikeness in average brightness between this and the second class is equal to the unlikeness in average brightness between the second and third class, and so on. The corresponding intensities of the physical lights have since been determined; and it is found that they approximately form the geometrical series, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, etc. Here each stimulus is the half of the preceding stimulus. Obviously $\frac{1}{2} : \frac{1}{4} :: \frac{1}{4} : \frac{1}{8}$, and $\frac{1}{4} : \frac{1}{8} :: \frac{1}{8} : \frac{1}{16}$; and $\frac{1}{2} : \frac{1}{4} :: \frac{1}{8} : \frac{1}{16}$.

In experimental investigations, attention has been chiefly given to degrees of unlikeness which are barely discernible.

Within limits, the stimulus may vary without any corresponding unlikeness in the sensation becoming perceptible.* The same law holds here also. The original stimulus, whatever its absolute intensity may be, must be increased by a certain constant fraction of its own amount, before any unlikeness in the sensation is discernible. The constant fraction is different for different kinds of sensation. In estimating weight merely by pressure on the skin, the ratio between original stimulus and increased stimulus must be 3 : 4 before an unlikeness is perceptible; or to use technical language, before the *difference-threshold* is passed. *Difference-threshold* is in some respects a misleading term: the facts do not warrant us in saying that there is no difference in the sensation before the threshold is passed, but that there is no discernible unlikeness in the sensation. It is better therefore to speak of the threshold of *discernment* than of the threshold of difference. For brightness of white light, unlikeness only becomes discernible when the ratio of the original stimulus to the increased stimulus is 100 : 101, or, in other words, when the increment is $\frac{1}{100}$th of the original stimulus. "If we place two candles so as throw two shadows of some object on a white surface, the shadow caused by each light will be illuminated by the other light, and the rest of the surface will be illuminated by both lights. If now we move one candle away we shall reach a point at which the shadow caused by it ceases to be visible, that is to say, we fail at this point to appreciate the difference between the surface illuminated by the near light alone and that illuminated by the near light and the far light together. If now, having noted the distance to which the candle had to be moved, we repeat the same experiment with two bright

* See book ii., chap. i., § 3.

lamps, moving one lamp away until the shadow it casts ceases to be visible, we shall find that the lamp has to be moved just as far as the candle; that is to say, the least difference between the illumination of the bright lamps which we can appreciate is the same as in the case of the dimmer candles. Many similar examples might be given showing a similar result, in fact, it is found by careful observation that, within tolerably wide limits, the smallest difference of light which we can appreciate by visual sensations is a constant fraction (about $\frac{1}{100}$th) of the total luminosity employed."*

It should be added that a stimulus must reach a certain degree of intensity before it can produce any discernible sensation at all. Physical light or physical sound may be too faint to be distinguishable. The point at which it is just indistinguishable, so that the least increase would make it distinguishable, is called the *stimulus-threshold.*

§ 2. *Interpretation.*—The explanation of the facts described has been much discussed. One hypothesis is that increase in the intensity of the stimulus fails to produce an increase in the intensity of the sensation until the increment is a certain fraction of the original stimulus. On this hypothesis the sensation ought to vary by leaps and bounds at certain fixed points. The reason why no unlikeness in the sensation is discernible before these points are reached is that no unlikeness in the sensation exists. This view may be definitely rejected. There are no such fixed points of transition. Whatever the intensity of the original sensation may be, the same relative increment is required to make unlikeness discernible. In gradually increasing the intensity of the stimulus, it is not found that there are certain points at which change in sensation becomes

* Foster, *op. cit.*, p. 1211.

perceptible in such a way that any pair of stimuli gives rise to distinguishable sensations, if they lie at opposite sides of the point of transition, however closely they may approach it. As a matter of fact, a sensation A may be indistinguishable from B, and B from C, and yet A may be distinguishable from C. If discernible unlikeness in sensation were co-extensive with actual unlikeness, this would be impossible. Another objection is that the power of discriminating very small degrees of unlikeness is greatly improved by practice, and varies greatly with the concentration of attention. It seems improbable that these conditions should have so great an effect on the actual intensity of sensation produced by the stimulus.

Another explanation is that adopted by Fechner. He rightly holds that the sensation varies with the stimulus even when the variation is not perceptible. It becomes perceptible when the degree of variation has passed a certain limit. So far, we may follow him. But he also holds that the increase in intensity of sensation required to constitute a discernible unlikeness is not relative but absolute, so that the variations of stimulus form a geometrical series, while the corresponding variations of the sensation form an arithmetical series. In estimating weight by means of pressure, if we begin with an ounce, we must add a third of an ounce before any unlikeness is discernible; if we begin with a pound, we must add a third of a pound before any unlikeness is discernible. In both cases, according to Fechner the increase in the intensity of the pressure-sensations is not relatively the same but absolutely the same. There are very serious objections to this view. If we compare the weight of an ounce with no weight at all, according to Fechner, the degree of unlikeness between the two

experiences ought to be strictly proportional to the difference between the intensity of sensation produced by one ounce, and the complete absence of pressure sensation. In other words, it ought to be proportional to the absolute intensity of pressure produced by one ounce. But as a matter of fact, the unlikeness between the zero value of a sensation and any finite value is infinite. Hence, for this limiting case, Fechner's interpretation breaks down. There is a difficulty in testing it in other cases, because of the peculiar nature of intensive magnitude. Intensive magnitude is indivisible. We cannot subtract a fainter sound from a louder so as to be able to point to a certain degree of loudness as the mathematical remainder. Hence we cannot in such cases immediately test Fechner's contention that the degree of unlikeness between two sensations is simply proportional to their mathematical difference,—to the remainder which would be left if one could be subtracted from the other. But there are other cases of the application of Weber's law in which this difficulty does not present itself. Weber's law holds good of extensive as well as intensive magnitude, and it also holds good of number. If we compare a line two inches long with a line three inches long, and then compare a line six inches long with a line seven inches long, according to Fechner the degree of unlikeness between the two inch line and the three inch line ought to be identical with the degree of unlikeness between the six inch line and the seven inch line. In both cases the mathematical difference is the same—one inch. This is true from the psychological as well as from the physical point of view. For if we suppose the lines to be presented to the eye under similar conditions, the mode in which an inch affects the retina in the one case may be virtually identical with the mode in which it affects the

retina in the other case. The inches are not only equal as measured by a rule; they also appear equal as they are presented to consciousness. We are therefore dealing with psychical, and not merely with physical, magnitudes. But in spite of the fact that $3 - 2 = 1$, and that $7 - 6$ also $= 1$, there is a greater degree of unlikeness between the line of two inches taken as a whole, and that of three inches taken as a whole, than there is between the line of six and that of seven inches. The same holds for least perceptible degrees of unlikeness. If we have to increase the length of a line of six inches by a certain amount in order that the unlikeness may be just discernible, we must increase the length of a line of two inches, not by the same amount, but in the same proportion, in order that the unlikeness may be just discernible. Number as well as extension affords illustration. If we lay a group of three counters on the table beside a group of two, and if we then lay a group of eight beside a group of seven, it is clear that there is a greater resemblance between the group of eight and the group of seven than there is between the group of three and the group of two. Yet in both cases the mathematical difference is the same—one counter; and it may appear to be the same as presented to consciousness. The principle holds also for magnitudes which are not directly perceived, but thought of. Everybody recognises that a billion and one is more like a billion than eleven is like ten. So in the ordinary dealings of life, if we have to pay or receive sums amounting to hundreds of pounds, we feel that it does not matter about odd pence; but a penny more or less is by no means negligible if the sum to be paid or received is under a shilling.

We may then conclude that degree of unlikeness between

the visible quantities is neither identical with their mathematical difference nor proportioned to it.

In the case of intensive magnitudes, such as the loudness of a sound, or the brightness of a light, there is, properly speaking, no mathematical difference, because we cannot divide such magnitudes into parts, so as to find a numerical equivalent for each, and subtract the one from the other. None the less, there may be in intensive magnitude something analogous to the mathematical difference. The velocity of a moving body is an intensive magnitude; but it is a magnitude which can be represented by a number which is a function of the space traversed and the time which it takes to traverse it. It may thus be treated as if it were an extensive magnitude capable of addition and subtraction. There is no reason why the intensity of sensation should not be conceived in the same way. At any rate, the mere fact that we are dealing with intensive magnitude does not in itself constitute an insuperable objection to the abstract possibility of such a mode of treatment. Hence there is in principle no objection to Fechner's attempt to correlate increased intensity of sensation with increased intensity of stimulus. But he was over-hasty in supposing that equal degrees of unlikeness involved equal absolute differences of quantity in the sensation. On the contrary, the analogy of extensive magnitude seems to show that degree of unlikeness is correlated with relative, not absolute, differences in intensity of sensation. Fechner's problem is yet to be solved. We do not yet know the law which connects increase in the strength of the stimulus with corresponding increments of sensation. We cannot yet assign a number which shall represent degrees of loudness or brightness, as the number obtained

by dividing the sum of units of time into the sum of units of space represents velocity.

§ **3.** *Further questions.*—It may cost more or less effort to discern an unlikeness. The difficulty is greatest when the unlikeness is very small. Now it has been maintained that what we really estimate when we suppose ourselves to be estimating degrees of unlikeness, is the degree of difficulty which we find in perceiving unlikeness at all; the greater the difficulty, the less the unlikeness. A simple consideration shows that this is untrue. The lower grades of unlikeness are specially difficult to distinguish; and, as the unlikeness is increased in degree, it becomes more easily discernible. But this holds only up to a certain point. When the unlikeness is sufficiently great it is discernible without appreciable difficulty, and after this further increase does not make it appreciably easier to perceive. We must therefore conclude that our judgment of unlikeness depends primarily on the actual unlikeness, and not on the ease or difficulty of detecting it. At the same time, the ease or difficulty of detecting an unlikeness may more or less affect our judgment of its amount. It may thus be a source of error, and may to some extent explain apparent deviations from Weber's law.

Here a question of some importance arises. It is often assumed without discussion that all least perceptible degrees of unlikeness between the same kinds of sensible qualities are equal. Now this is by no means self-evident. It is indeed not self-evident that degrees of unlikeness which are just discernible, are therefore equally discernible, that is to say, discernible with equal ease. Even if they are all discernible with equal ease, it does not follow that they are themselves equal. The appeal in

the last instance must be to actual comparison. A valid reason for assuming them to be equal is that they appear equal. Another reason is that they occur under the conditions of Weber's law, which holds in general for equal degrees of unlikeness.

A stimulus must reach a certain degree of intensity before it can produce any discernible sensation at all. The question arises whether it produces any sensation before it produces a discernible sensation. Proceeding on the general analogy of the results we have reached in discussing Weber's law we must assume that in all probability it does. We have here a special case of the general relation of stimulus to sensation. Within limits, the sensation varies as the stimulus is increased, without the variation becoming perceptible. It is most natural to bring the case of a stimulus, which is not yet intense enough to produce a discernible sensation at all, under the same principle. It is still more improbable that sensations which escape notice merely because our attention is otherwise occupied have no existence as psychical facts. Thus, from our present point of view, we can reinforce the argument of Bk. II., ch. i., § 2.

§ 4. *Limitations of Weber's Law.*—We have spoken of Weber's law as if it held good exactly and uniformly for all sensations; but as a matter of fact this is far from being the case. Many deviations and limitations have been discovered by experiment. Verification commonly fails for very high or very low intensities of sensation. In view of the complexity of the operative conditions this is not in the least surprising. Our power of discriminating may be influenced by many factors besides the actual nature of the sensations which we have to compare. The relation between intensity of stimulus and absolute intensity of

sensation may, and probably does, depend upon many other conditions than the mere intensity of the stimulus itself. We may suppose the law to be perfectly exact, inasmuch as it states that unlikeness between sensations depends upon their relative difference, without supposing that this relative difference is determined only by difference of external stimulation. The special structure of the different sense-organs is probably an important factor. To speak of nothing else, the eye and the ear have sensations of their own due to internal stimulation, which it is difficult to allow for.*

The treatment of Weber's law in this chapter follows Meinong, *Ueber die Bedeutung des Weberschen Gesetzes*, etc.

CHAPTER VIII.

THE FEELING-TONE OF SENSATION.

§ 1. *Common Sensibility.*—The pleasure and pain connected with organic sensations are of fundamental and all-pervading importance in our mental life. Normally, these sensations are fused in a total mass of experience, which can only be very partially analysed into its components by attentive scrutiny. The membranes which line our internal organs are generally supplied by sensory nerves, which, from all parts of the body, are perpetually conducting a multitude of impressions to the central nervous system. On the resultant effect of these impulses it depends whether at any moment we feel well or ill, cross or complacent. By the nature of our organic sensations in the morning we can often predict whether the day's experiences are going to be agreeable or disagreeable. The feeling-tone of common sensibility determines in large measure the feeling-tone of more special experiences in the way of sensations, perceptions, and ideas. An incident which might be pleasant or but slightly disagreeable if we were feeling fresh and "fit," is apt to be intensely disagreeable if our organic functions are out of order. This is too well-known a fact to need extended illustration. Smells and tastes which are agreeable to the healthy person may be highly unpleasant to the invalid. After a full meal, food which

was previously delicious may become almost nauseous; even the idea of it may be unpleasant. The very thought of smoking a pipe in certain states of body may be repellent in the case of persons who usually enjoy the use of tobacco. The profound alteration of organic conditions which accompanies pregnancy produces curious "longings" and repugnances for articles of food. It thus appears that organic sensations influence the whole state of the central nervous system.* The neural processes connected with special sensations are more definitely restricted and localised. The experiences due to common sensibility are diffusive in their character. They give to the nervous system a certain general predisposition, and on the psychical side produce a certain general mood or temper.

By reflective scrutiny it is possible, as we have said, to detect special components of the total complex of organic sensation, such as those due to the heart-beat, and respiration, and the shiverings of cold or glows of warmth arising from contraction or dilatation of the blood-vessels at the surface of the body. But there are occasions when no special effort of attention is required to detect an organic sensation. The experiences immediately due to a toothache, to a colic, to muscular cramp, to a burn, a bruise, or a blow, usually compel attention, whatever other interests may compete with them. When one organic sensation detaches itself from the mass of common sensibility, it is apt to be overwhelmingly obtrusive. Such intense experiences

* Besides receiving sensory impressions from the internal organs, the central nervous system is also directly affected by general organic conditions, and in particular by the character and amount of the blood-supply which flows to it. This factor must also contribute to determine the general nature of experience as pleasant or unpleasant. Its relative importance as compared with the more indirect effect of sensory impressions upon the internal organs is difficult to estimate.

are much more often painful than pleasant; but they also occur in agreeable phases. In general, the satisfaction of organic cravings, such as hunger and thirst, may be intensely agreeable. The peculiarly disagreeable character of most organic sensations which are intense enough to detach themselves from the general mass, is marked by the usage of popular language which applies to them in a restricted and distinctive sense the word *pains*. A bitter taste or a discord may be disagreeable, but it is not usually called a pain. On the other hand, we currently speak of the pains of hunger, of scalding or burning, or of toothache. The reason is that the main importance of such experiences lies in their intrinsic feeling-tone. They have comparatively little value for cognitive consciousness. They contribute comparatively little to the discrimination of the qualities of external bodies; and they yield only more or less vague information about the condition of our own bodies. When we have received a wound, we have to look at it to find out its precise character and the proper mode of treating it. The pain-sensation itself does not help us much.

It must be noted that those sensations which are in popular language called, by a distinctive application of the word, *pains*, have other characteristics besides their mere unpleasantness. The feeling-tone does not exist in abstract purity: it is always the feeling-tone of some sensation having a more or less determinate character of its own. It is through the character of the accompanying sensation that we are able to distinguish different kinds of organic pain or pleasure. Thus we discriminate from each other stinging, piercing, gnawing, crushing, beating, shooting, burning, and innumerable other kinds of pain. Hence it is possible to

compare pain-sensations in other respects than the intensity of their painfulness. The points of agreement and difference are to a large extent to be found in the temporal and local distribution of the constituents of a complex experience. Local distribution is marked by such terms as *pricking*, *shooting*. Temporal sequence and rhythmic alternation are marked by such terms as *throbbing*, *beating*, and the like. These differentiating qualities which we use in describing the varieties of pain-sensation have usually little cognitive value of any other kind. So far as cognitive consciousness is concerned, their main function is fulfilled in enabling us to detect and express the difference between one kind of pain and another. It is therefore natural that in naming them we should apply to all indifferently the common word *pain*. But it is better to speak of *pain-sensations* than of *pain*, in order to indicate that something besides mere unpleasantness is involved. Markedly analogous experiences may also occur without any intensely disagreeable feeling-tone. A slight burn may retain much of the peculiar prickly, pungent, quality of the original sensation when the painfulness has almost or quite disappeared. So it is possible occasionally to detect the peculiar throb characteristic of a toothache, and the tenderness of the gum, when the acutely disagreeable phase of the experience has passed away or has not yet arrived. Hunger is usually unpleasant, but sometimes the beginning of it does not appear to be so.

So far we have referred only to those distinctive features which serve us in *describing* the difference between one pain-sensation and another. But there are undoubtedly other differences which seem incapable of analysis and description. This follows from the diffusive nature of organic sensations. The particular sensation which we

regard as painful may have its origin in a burn or a wound in a particular part of the skin, or in a diseased condition of the membrane of the stomach or bowels. The specific nature of the experience will therefore be in part determined by the character of this primary sensation. But the disturbance set up by the localised impression tends to involve more or less the whole nervous system, and to overflow the whole organism. The diffused effect on the nervous system may be marked by some peculiarity in the experience. Certainly, the impressions which arise from the changed conditions of the organism as a whole must modify the total experience in an important degree. But these elements are not easily expressed in definite language. They can, as people say, be felt but not described.

Organic pains and pleasures in extreme degrees of intensity reduce to a minimum cognitive process in general. In having a tooth drawn, our consciousness seems to consist in a single thrill of mere sensation. Attention to definite objects ceases: we cannot be said to attend even to the sensation itself, except in the vaguest way. We do not take note of its peculiar qualities, we simply feel it. The distinction between subject and object seems for the moment almost lost. It remains true that the experience has a peculiar quality which might be analysed and described by a demon which had taken possession of us and was watching our mental processes. But no approach to such analysis and description is possible to us until the experience is over, and we can calmly regard it in retrospect.

Pain-sensations may arise through disintegration of tissue or excessive stimulation in almost any part of the surface of the body. The question arises, how far they are

due to the existence of nerves of common sensibility terminating in the skin and other sensitive surfaces, and how far they may be produced by stimulation of the nerves subserving the special senses. It appears probable that stimulation of the nerves of sight and hearing does not result of itself in pain-sensations, strictly so called. But the case of cutaneous impressions is more doubtful. Goldscheider has found that a continued series of taps on a point peculiarly sensitive to pressure may suddenly give rise to a new sensation distinctly different in kind from those of pressure which had previously accompanied the several taps. This new sensation, due to the cumulative effect of repeated impressions, is organic in its nature, and bears the general character of a pain-sensation although it may not be acutely painful. Now the question may be raised whether the same nerve-endings which were the medium of the sensation of pressure were also the medium of this other sensation. Again, let us suppose a needle-point thrust into the skin; at first only a sensation of pressure is felt, which may be more or less disagreeable. It is only after the lapse of an appreciable interval of time that the pain-sensation of pricking occurs. The time-interval points to the possibility that the pain-sensation and the pressure-sensation, respectively, are subserved by different nerves. This view appears to be reinforced by certain pathological phenomena. There are cases when sensitiveness to temperature and pressure remains intact while pain-sensations are no longer producible. This sometimes happens to patients under chloroform or other anaesthetics. It also occurs in lead-poisoning and in some cases of nervous disease. The inverse also may take place. Susceptibility to pain-sensation may be retained, though pressure- and temperature-sensations are no longer

producible. These facts seem to show that the nerves of common sensibility and those of special sensations are distinct and separate. But there is one weak point in the argument. The pathological phenomena only occur under conditions which produce abnormal states of the nervous system. We may explain the facts, not by supposing separate and distinct sets of nerve-fibres terminating in the skin, but by supposing that the effect of the same impression on the same nerve is altered by the altered state of the central nervous matter to which it is conveyed. It has been found that removal or disablement of the grey matter of the spinal cord produces insensibility to pain-sensations, while sensibility to pressure- and temperature-sensations is left unaffected so long as the white strands of the cord remain intact. Conversely, cutting through the white strands of the cord destroys sensitiveness to pressure- and temperature-, but not to pain-sensations. Now before a nervous impulse can be transmitted through grey matter, it must first excite the grey cells so that they discharge in an explosive manner. For this the impulse communicated to them must reach a certain pitch of intensity, and after their discharge the impulse is transmitted in an intensified form. They thus serve as accumulators of nervous energy. In this way we may explain the sudden emergence of a new sensation as the result of a series of successive taps on a pressure-point. Each tap gives rise to a relatively feeble nervous impulse, which by itself is insufficient to produce a discharge of the grey cells of the cord. But the series of taps by its cumulative effect ultimately succeeds in producing an explosion of the grey matter, and with it a new sensation of an organic character. When the grey matter of the spinal cord is removed, the nervous impulses from the

skin, whatever their origin, may fail to produce pain-sensations because they cannot attain the requisite intensity in the absence of an apparatus for accumulation of nervous energy. But there is no reason why they should not still continue to produce pressure- and temperature-sensations. Similarly, in the inverse case, all nervous impulses from the skin, in order to produce any sensation at all, must discharge the grey matter of the cord, and in so doing reach a pitch of intensity that can only give rise to pain-sensations. It seems, therefore, very possible that the nerves which subserve temperature- and pressure-, may also subserve pain-sensations, the difference between the two kinds of experience depending upon more central conditions.

§ 2. *The Special Sensations.*—We now turn to consider the special sensations of sight, sound, smell, taste, touch, and temperature. The feeling-tone of these sensations varies, first, with their intensity, secondly, with their duration, and thirdly, with their quality.

(1) Many of them in a low grade of intensity appear to be virtually neutral. All of them acquire appreciable feeling-tone as their intensity is increased. Some of them are unpleasant even when they are weak. All of them become unpleasant when intensified beyond a certain point. Before reaching this point they nearly all have an agreeable phase; after reaching this point they continue to be more and more disagreeable as intensity increases. It is a matter of dispute whether there is any sensation which is constantly disagreeable in whatever phase of intensity it appears. It is always possible to urge that though a sensation is generally disagreeable, it might be agreeable if it could be made weak enough. As an example of a pleasant phase of an experience which everybody would

regard as absolutely disagreeable from its very quality, we may quote the following from Mr. H. R. Marshall: "I remember well once having been aroused from serious thought in a railway carriage by a delicious odour, and the words 'What a delightful perfume!' were actually formed in thought. Almost immediately the smell changed to disagreeableness with growing intensity, and there appeared evident the intensely disagreeable smell emitted by a polecat which had been killed by the train."* We may formulate the general rule for the relation of intensity and feeling-tone as follows. A sensation must reach a certain minimum of intensity in order to have an appreciable feeling-tone. Further rise in intensity of sensation is accompanied by a rise in intensity of feeling-tone. If the sensation is initially unpleasant, its unpleasantness continues to increase as the sensation is intensified. If it is initially pleasant, the pleasantness increases to a certain maximum, at which it remains roughly constant until the intensity of the sensation is increased beyond a certain limit. When this limit is passed, the pleasantness decreases, and finally passes into unpleasantness.†

The nature of the transition from pleasantness to unpleasantness requires further elucidation. An unpleasant element appears to enter into the experience even while the original sensation continues to be in itself agreeable. This is sometimes distinctly traceable to other definitely assignable sensations, which are superadded to the primary one. Thus, at a certain pitch of intensity, warmth may continue to be still agreeable in itself, although it is accompanied by a distinctly disagreeable sensation of a prickly or pungent character, probably due to stimulation

* *Pain, Pleasure, and Aesthetics*, p. 288.

† See A. Lehmann, *Die Hauptgesetze des menschlichen Gefühlslebens*, p. 181.

of pressure-points in the part of the skin affected. So a bright light may continue to give pleasure when it is so intense that the effort to accommodate the eye to it is unpleasant. But there are other cases in which it is much more difficult to assign definitely the source of the collateral unpleasantness. However intense sweetness may be, it scarcely seems to become in its own intrinsic nature disagreeable. At the same time, it may excite strong disgust, which seems to be connected with accompanying organic sensations not easy to analyse or describe.

(2) The dependence of feeling-tone on duration varies in nature according as the sensation is continuously maintained or repeated intermittently.

There appears to be no appreciable interval of time between the emergence of a sensation of given intensity and the corresponding feeling-tone. Apparent exceptions can be explained away. If we touch a disagreeably hot object, the heat is felt before the unpleasantness; but this is because the stimulus requires a certain time before it can take full effect. On its first application the sensation is not intense enough to be disagreeable.

The following is the general formula for variations of feeling-tone with the continuous persistence of the sensation in time. The feeling-tone increases in intensity to a maximum. If the sensation is pleasant, it continues for some time at this maximum, and then gradually becomes less agreeable, and in the end distinctly disagreeable. If the sensation is initially unpleasant, the maximum persists for a much longer period than in the case of agreeable sensations. After this, the unpleasantness may become fainter, but it never passes into pleasantness, and it is always liable to reappear at intervals in more intense phases.

The same remarks which we made about the transition from pleasantness to unpleasantness with rise in intensity, apply to the same transition as dependent on continuous persistence in time. Here also collateral elements of a disagreeable kind are introduced into the experience before the primary sensation becomes in itself unpleasant. The illustrations of the bright colour and of the sweet taste may be transferred, *mutatis mutandis*, to the case of duration. A boy eating sugar-plums, if he continues to indulge himself beyond a certain point, has disagreeable sensations distinctly traceable to the stomach and other internal organs, while the sweetness itself remains sufficiently agreeable to tempt him to go on eating. But even apart from such definitely assignable collateral accompaniments, there may be a surfeit of sweetness, though sweetness remains in itself an agreeable taste. Doubtless this is due to some general organic effect hard to define by introspective analysis. Sometimes the disagreeableness is simply due to tedium; if we gaze at a bright colour too long we feel bored because of the suspension of other activities, although the colour continues to be pleasing.

The case in which the sensation is repeated intermittently is in many ways analogous to that in which it persists continuously. If the repetition is too frequent, a pleasant sensation tends to become less pleasant, and often becomes unpleasant. Unpleasant sensations by frequent repetition often, but by no means always, become less unpleasant. They may even become virtually neutral or even actually pleasant. Perhaps the best instance of a disagreeable sensation becoming agreeable by repetition is the "acquired taste" for olives.

When a pleasant sensation by repetition does not lose

its pleasantness and become disgusting, and when an initially unpleasant sensation has become more or less pleasant by repetition, its absence from consciousness will at certain moments give rise to a craving for it. The craving of the smoker for tobacco, of the olive-eater for olives, or of the drinker for his bitter beer, are cases in point. Certainly, the effect is most marked when originally unpleasant sensations have become pleasant by repetition. The nervous system has adapted itself to certain modes of excitation returning at certain intervals, and their absence produces a disturbance of neural equilibrium. If a person is in the habit of using tobacco only at fixed times in the day, the craving is apt to arise exclusively at these times. The omission of a customary early morning pipe may trouble the smoker in the early morning, but the craving may pass away and not recur during the day.

(3) We have seen that there are probably some sensations which are disagreeable in all phases of intensity. Others become disagreeable at a very low intensity. In the case of others, such as sweetness, it is not quite certain that they ever become intrinsically disagreeable, even when they are most intense. It follows that quality of sensation is a most important factor in determining feeling-tone. We can do little to explain why one quality is predominantly agreeable and another predominantly disagreeable. The nearest approach to an explanation is found in the special case of complex sound-sensations. The disagreeableness of dissonance is due to the presence of beats which interrupt the uniform course of the periodic stimulation of the organ of hearing. The central nervous matter has adapted itself to a certain rhythm of excitation, and this rhythm is disturbed by the beats. We have no

similar reasons to assign why certain combinations of odours and tastes are agreeable, and others disagreeable.

§ 3. *Surplus Excitation.*—It is clear that the agreeable or disagreeable feeling arising in connexion with the occurrence of a sensation may not be wholly due to the quality or intensity of the sensation itself. "If one is listening to a series of sounds, or looking intently at some object, the feeling of 'distraction' caused by being spoken to in a whisper, or lightly touched," is comparable with sharp physical pain.* The whisper or the light touch may be in no way disagreeable in themselves; they may be virtually neutral; but they set up a general nervous and bodily disturbance, correlated with a general mental disturbance of an intensely unpleasant character. A similar shock is experienced when, in the process of going to sleep, we are startled by some sudden sound, which need not be especially loud. There is in such cases a diffused excitement of the nervous system, produced by the sensation, and superadded to that special excitement which is immediately correlated with the existence of the sensation. Following Professor Ladd, we may call this diffused effect the "surplus" excitation. Its occurrence is by no means confined to such exceptional experiences as that of being startled; on the contrary, all sensations which have a distinctly appreciable feeling-tone, appear to have a more or less diffusive character. In this respect, the difference between the organic sensation produced by a wound, and the special sensation produced by a bright light, is only one of degree.† To some extent this statement may be directly verified by introspection: wherever

* Ladd's *Descriptive Psychology*, p. 199.

† Hence there is no sharply marked line of demarcation between pain-sensation and the disagreeableness of special sensation. When unpleasant organic accompaniments become prominent, pain-sensation arises.

feeling-tone is sufficiently intense, we can detect a diffused bodily and mental excitement, and concomitant change in our organic sensations. An intensely bitter taste may give rise to a cold shiver; the piercing scream of a railway whistle disturbs thought and perception, and is felt over the whole organism. A delicious taste may not only tickle the palate, but "set the whole man a-gog"; the strong pleasure or displeasure sometimes produced by stroking, tickling, or rubbing, is not immediately due to the quality and intensity of the tactile sensations themselves, but to the surplus excitement they produce. We mentioned previously that sensations in themselves agreeable may in their general effect be unpleasing, and we found that the collateral unpleasantness can only in part be accounted for by the concomitance of definitely assignable and describable experiences. But surplus excitation, with consequent modification of common sensibility, adequately explains these subtle and evasive affections of consciousness. In the same way we are able to account for the qualitative diversity of the feeling-tone of different sensations which agree in being pleasant or unpleasant. The pleasure of a sweet taste differs in kind from that of a bright colour or of a musical note; and the difference cannot be wholly identified with the qualitative diversity of the sensations of sight, taste, and hearing themselves. Besides the variety of primary sensations, there is also a distinction between the kinds of pleasure which they afford. The several experiences contain elements which fulfil no other cognitive function than that of enabling reflective analysis to discriminate diverse modalities of feeling-tone. The existence of these diverse modalities has been strongly emphasized by Professor Ladd. "*The way we feel* is not by any means precisely the same for all equally pleasurable

or equally painful, tastes and smells. Some agreeable sweet odours are described as 'heavy,' and others as having an 'enlivening' or 'spicy' quality."* Compare, for instance, the heliotrope and the Japanese lily. The strong organic effect which may be produced by a powerful odour is shown by its sometimes causing highly susceptible persons to faint. "Pleasant coolness is 'refreshing': pleasant warmth is 'cherishing.' ... Musicians have always attached different distinct kinds of feeling to different musical instruments," and "to different keys and chords ... The 'grave' feeling belonging to the bass register is different otherwise than in mere quantity of pleasure-pain from the 'stirring' of the tenor."† These various experiences tend to induce certain moods having affinity with distinctive emotions. The same is true in a less degree of colours. "Bright light and mellow light produce differences in the character of the equally pleasurable feeling which may result."‡ Goethe contrasts the "cheerfulness" of a view as seen through yellow glass with its "mournfulness" as seen through blue glass. These differences in feeling-tone cannot be reduced to the mere difference between pleasantness and unpleasantness; and they cannot be identified with the qualitative differences between the sensible qualities which occupy attention, and which are said to be pleasant or unpleasant. We must refer them to a more or less diffused excitement of the nervous system with its organic consequences, and the resulting modifications of common sensibility.

We have asserted that "all sensations which have a distinctly appreciable feeling-tone, appear to have a more or less diffusive character."‖ But we have not so far adduced evidence sufficient to justify this position in its full extent.

* *Op. cit.*, p. 184. † *Op. cit.*, p. 185. ‡ *Ibid.* ‖ § 3, p. 222.

Fortunately the deficiency is supplied by experiments, which show that pleasant and unpleasant sensations in general produce organic effects differing in a characteristic way according as they are agreeable or disagreeable. By suitable apparatus it is possible to measure variations in the volume of the limbs, and in the respiratory movements, while the subject is undergoing pleasant or unpleasant experiences. The variations are recorded by a curve traced upon a revolving cylinder. The curve for the volume of the limb indicates, besides larger and longer variations, also smaller and shorter variations due to the beat of the pulse. The general results deduced from a careful analysis of these experiments are as follows.

Pleasant sensations, such as that of a sweet taste or of a good cigar smoked by a person who enjoys it, produce increase in the volume of the limbs due to dilatation of the blood-vessels at the surface of the body. They also produce an increase in the height of the pulse-beat, which may be in part due to increased contraction of the heart. The respiration is deepened, and probably the muscles under the control of the will are in general more strongly contracted.

The case of unpleasant sensations is more complicated. On the first introduction of the unpleasant stimulus, the volume of the limb is distinctly diminished, owing to constriction of the blood-vessels at the surface of the body. The constriction at the surface of the body is probably accompanied by a dilatation of the blood-vessels of the internal organs. The amplitude of the pulse-beats is diminished. At the same time, there is a deepening of respiration; and when the stimulus is strong, there is a conspicuous contraction of the voluntary muscles in general. Later phases of the process present different phenomena.

After its initial diminution, the volume of the limb begins to increase, and continues increasing for some time. This increase is not supposed to be in the first instance due to dilatation of the blood-vessels, but to accumulation of venous blood arising from decreased activity of the heart. But dilatation of the blood-vessels following by way of reaction on their previous constriction is supposed to contribute to it at a later stage. The increased innervation of the voluntary muscles is also followed by a corresponding relaxation.

These experiments justify the assumption that all sensations having a distinctly appreciable feeling-tone produce a diffused organic effect, which differs in a characteristic way, according as they are pleasant or unpleasant.

There thus appear to be three factors which may contribute to determine feeling-tone: (1) The sensation itself; (2) The diffused excitement of the nervous system which it may produce; (3) The effect of this diffused excitation on the organism by the consequent alterations of common sensibility which arise from the altered state of the internal organs. All three factors probably contribute to the result in varying degrees according to circumstances. It seems arbitrary to select one of them as alone important to the exclusion of the others: but some writers show a tendency to do so. For instance, Professor Ladd lays stress exclusively on the diffused excitement of the nervous system directly occasioned by the occurrence of the sensation. He seems to regard the sensation itself as devoid of feeling-tone, and he seems to attach little or no importance to the organic sensations which it indirectly produces. But introspection shows that a sensation may be in itself agreeable or disagreeable apart from its effects. Thus, sweetness

may in its own intrinsic nature be agreeable, though on the whole it awakens disgust. Another view, which seems favoured by Professor James, is that feeling-tone belongs exclusively, or almost exclusively, to organic sensation. He is not very clear on the point, but it seems to form part of his celebrated theory of emotion that, apart from organic sensation, our mental states would consist almost wholly in cold intellectual perception without feeling-tone. At any rate, it is important to discuss the point, if for no other reason, because of its bearing on a theory which we shall have to examine later,—the theory which reduces emotion, and the pleasantness and unpleasantness of emotion, to organic sensations and their feeling-tone.

On the psychological side, the distinction between pleasantness and unpleasantness is simple and ultimate. If it is due to a difference in organic conditions, we should expect this difference to be equally simple. Now we do not find that the contrast between the organic processes is correspondingly simple. On the contrary, even those organic concomitants of feeling-tone which can be detected by experiment are very complicated. Thus, in the case of unpleasant experiences, initial constriction of the blood-vessels at the surface of the body is accompanied by dilatation of the blood-vessels of the internal organs. The constriction of the surface is in a subsequent phase of the process probably followed by dilatation at the surface. The initial diminution of the volume of the limb is followed by increase due to accumulated venous blood. So increased contraction of the voluntary muscles is followed by relaxation. Hence we cannot single out any general form of organic stimulation as the universal and uniform condition of unpleasant feeling-tone. There is therefore no theoretical advantage in ascribing feeling-tone exclusively to organic sensations.

The same problem confronts us in regard to them as in the case of the special senses. They constitute a heterogeneous group of experiences, some of which are pleasant and some unpleasant. Each of them has, besides its feeling-tone, its own specific quality as a sensation, and this quality may be almost neutral in tone, or it may have both agreeable and disagreeable phases according to its intensity, or according to the general mental condition at the moment. Neither in their internal nature, as analysed by introspection, nor in their mode of origin, do organic sensations present any peculiar characteristics which would justify us in making so vast and important a distinction between them and the sensations of the special senses, as is involved in affirming that they alone can be pleasant or painful, while the sensations of the special senses are neutral. It is true that organic sensations have a peculiarly diffusive character, but even in this respect the distinction between them and the special sensations is only one of degree. A positive argument against the hypothesis may be derived from the fact that the emergence of a simple sensation in a given phase of intensity, and the emergence of its feeling-tone, are not separated by any appreciable interval of time. But the production of organic changes by the original stimulation of the nervous system, and the production of organic sensations in consequence of these changes, is a process which must occupy an appreciable time. In fact, the later addition of new elements to the original experience can frequently be detected by introspection. A very bitter taste may, as Lehmann remarks, appear at first merely as a disagreeable bitterness, which is followed only after an appreciable interval of time by a cold shiver due to constriction of the blood-vessels.

We conclude therefore that it is unjustifiable and

arbitrary to ascribe feeling-tone exclusively either to the primary sensation, or to the surplus nervous excitement which it produces, or to the resulting organic sensations. All three factors contribute, and they may contribute in different proportions according to circumstances.

§ 4. *Feeling-tone and Organic Welfare.*—Most psychologists support the general thesis that the processes corresponding to agreeable sensation promote organic welfare, and that those corresponding to disagreeable sensation are injurious. Stated more definitely, this means that agreeable process contributes to efficient discharge of function in the organs which it affects, and that disagreeable process disables the organs it affects. There are two senses in which the general proposition can be understood. The meaning may be that on the whole and in the long run a pleasant experience contributes to the welfare of the organism. The proposition understood in this sense no doubt holds good as a general rule, but it is a rule which has many exceptions. Any race of animals which should as a rule be pleased by conditions injurious to them and pained by conditions beneficial to them, would certainly perish in the struggle for existence. But to preserve the species in the struggle for existence, it is not necessary that pleasure should infallibly and universally coincide with ultimate benefit, and that displeasure should infallibly and universally coincide with ultimate injury. Hence we find that many things may be agreeable which are injurious, and inversely many poisons are palatable. Intoxication is very bad for the health; but it may be very pleasant.

If we are to establish a universal law, we must consider only the immediate vital activity at the moment in which the pleasant or painful sensation occurs. Sugar of lead has a sweet taste, which is pleasing at the moment; this

pleasing taste may in itself be favourable to vital activity, although the substance which occasions it, when introduced into the blood, acts as a deadly poison. Similarly, a bitter drug which is disagreeable to the taste may have a beneficial medicinal effect. The beneficial effect is not due to the disagreeable bitterness, but to subsequent effects entirely disconnected with the original experience. The case of intoxication by alcohol is different. Here the very process which is correlated with pleasure involves a disablement of the central nervous system. The efficiency of the intoxicated person, both for thinking and acting, is impaired. But this kind of exception also may be explained away. The intoxicated person is disabled from accurate methodical thinking, and from precise and delicate co-ordination of movement with a view to an end. But in general he makes no serious or strenuous attempt to fulfil these functions. If he does make serious efforts of the kind, he finds them very disagreeable. On the other hand, the loose and varied flow of ideas which accompanies the pleasing phases of intoxication, is much more free and expansive than in a state of perfect sobriety. We all know that champagne promotes conversation having a certain kind of brilliancy; and we all know that the opinions expressed and the arguments used are not likely to bear examination in sober moments. Even when there is no varied flow of ideas, even when a man persists in reiterating the same thing over and over again, his pleasure is connected with the fact that the point he is urging presents itself to him with peculiar vividness and intensity. Thus it appears that in the pleasing stages of intoxication a man is disabled from certain higher forms of mental function; but he does not have disagreeable feelings, simply because conscious activity in these

directions is suspended. On the other hand, the kind of conscious activity which continues to go on is not impaired, but intensified, and he consequently feels pleasure.

In this last example, we have referred especially to process in the central nervous system. It is in this only that, as psychologists, we have an essential interest. Pleasure and pain are states of consciousness, and consciousness is immediately correlated with neural process. Hence, the question which really concerns us is whether disagreeable processes are essentially connected with obstruction or disablement of conscious and correlated nervous activity, and agreeable processes with the free and unobstructed flow of such activity. If we state the question in this form it seems that the answer must be distinctly affirmative. Disagreeable sensations, in proportion to their intensity, obstruct and disturb mental process and the motor activities which, for their effective discharge, require conscious guidance. Everybody knows how difficult it is to think or act efficiently with a toothache or a headache, even though the desire to do so is strong. It is not merely that the painful sensations divert attention; this is true of pleasant sensations also, of similar intensity; the point is that the disagreeable sensations positively disorder and enfeeble thought and action, when the endeavour is made to think or act. Of course, if the disagreeableness arising from this or that special sensation is faint, and if the total state of consciousness is, on the whole, agreeably toned, in spite of the presence of this or that disagreeable item, the obstruction to mental activity may not be appreciable. But in principle it seems a safe generalisation that agreeable experience is favourable, and disagreeable experience is unfavourable, to the effective discharge of mental functions.

§ 5. *Feeling-Tone and Conative Tendency.*—Some pleasures of sense are dependent on pre-existing conations. There are sense-cravings connected with the primary organic needs, such as the need for food and drink; and the gratification of these cravings is a source of sense-pleasure. Similarly, the induced cravings for tobacco and alcohol, which recur of themselves at intervals, give a pleasure whenthey are appeased which is quite distinguishable from the pleasure immediately due to the stimulus apart from the craving for it.

Every pleasing and every painful experience at the time at which it is actually taking place has a conative, or at least a quasi-conative, aspect. In so far as the experience is pleasing, there is a tendency to maintain and develop it by whatever means may be found effective, until its pleasure-giving capacity is exhausted, or is overpowered by the intermixture of unpleasing elements. In so far as the experience is unpleasant, there is a tendency to discontinue it by whatever means may be found effective. Thus, on the level of mere sensation, agreeable feeling-tone corresponds to the positive phase of conation, and disagreeable with the negative. The pleasant experience is coincident with a conative tendency which requires for its satisfaction the continuance of the experience. The unpleasant experience is coincident with a conative tendency which requires for its satisfaction the discontinuance of the experience. While pleasure lasts, conation is being satisfied; it is working itself out. When satiety is reached, it has been satisfied: it *has* worked itself out and reached its termination. Until satiety is reached, there is always a tendency for the process to go on. If the pleasing sensory process is discontinued or obstructed before satiety is reached, the conation continues and is

intensified; there is added to the tendency to continue the pleasing sensation the tendency to get rid of the unpleasing state due to its interruption. The original conative tendency, which was in process of being gratified, is transformed into a thwarted craving. Suddenly snatch away the bottle from the baby who is complacently sucking it, and you will have a picture of the situation referred to. The reverse of all this holds good of disagreeable experiences. To discontinue them, however abruptly, is to give satisfaction and not dissatisfaction. Their continuance always thwarts and never appeases the conative tendency, which is essentially connected with their existence.

It should be carefully noted that we distinguish between ultimate satisfaction and the process of becoming satisfied. Ultimate satisfaction is attained only when satiety is reached,—only when the subject has had enough of the pleasant experience, so that, if it were still maintained, it would cease to please him. Pleasure is found in the process of becoming satisfied, not in its completion. Its completion is its termination, and therefore the termination of its feeling-tone.

We said that every agreeable or disagreeable sensation has a conative or quasi-conative aspect. The words "or quasi-conative" were added to meet a possible difficulty. Some psychologists hold that certain pleasing sensations appear purely passive, so far as introspection can analyse them. They do not appear to involve any experience of endeavour, or striving. I do not agree with these psychologists; but the question is a subtle one. It seems therefore best to evade the difficulty by pointing out that for our purpose it is not essential whether the tendency is experienced or not, so long as it exists. It will not be denied that there is at least an unconscious

tendency to continue a pleasing experience until we have had enough of it.

Any pleasing sense-experience, when it has once taken place, will, on subsequent occasions, give rise to a conation, when its conditions are only partially repeated, as when the object with which it is connected is perceived, or the corresponding idea is reproduced. The impulses and desires thus occasioned have both agreeable and disagreeable phases. They are for the most part agreeable when gratification comes quickly, or is anticipated with confidence. They are disagreeable when gratification is long withheld, especially if it be withheld in a tantalising way, so as to produce disappointment, or a series of disappointments. The experience is also apt to be more or less disagreeable when anticipation is not confident, but doubtful and hesitating.

§ 6. *General Theory.*—Whatever conditions further and favour conation in the attainment of its end, yield pleasure. Whatever conditions obstruct conation in the attainment of its end, are sources of displeasure. This is the widest generalisation which we can frame, from a purely psychological point of view, as regards the conditions of pleasure and displeasure respectively. Its application to the feeling-tone of sensation is already contained in the last section. A pleasing sense-experience operates as a positive factor satisfying the conative tendency or quasi-conative tendency which is essentially connected with it. On the contrary, an unpleasing sense-experience operates as a positive factor thwarting the conative tendency or quasi-conative tendency essentially connected with it. This is at the best only a vague explanation of sense pleasure-pain. It can only be regarded as being an explanation at all on one assumption. If it is supposed that, first, pleasure exists,

and that, subsequently to its occurrence, the conative tendency arises as a consequence, it is a logical circle to explain the pleasure by reference to the conation. But, as a matter of fact, there seems to be no reason whatever for supposing that feeling-tone and conation are separated in time. From the very beginning they appear to coincide. From the very beginning a pleasing process is a process which tends to maintain itself.

We may hope to attain a more definite insight into the ultimate conditions which determine the feeling-tone of sensation from the physiological side. But from that side we have not at present any direct knowledge of the nervous processes involved. We can only frame hypotheses to cover the psychological data.

If we attempt to translate into physiological language the general relations of pleasure and displeasure respectively to conative tendencies, perhaps the best result we can obtain is the following. Conation in general appears to correspond to a disturbance of nervous equilibrium, and its completed satisfaction to a restoration of equilibrium. The conditions of displeasure not only disturb nervous equilibrium, but also, so long as they continue, obstruct the processes by which it tends to be restored. On the other hand, the continuance of the conditions of pleasure is a factor positively operative in the restoration of equilibrium. It is evident that even if this view of the case be granted, there is still abundant room for further speculation as to the precise nature of the physiological processes corresponding to pleasure and displeasure respectively. The most favoured theories of the kind connect these opposite feeling-tones with the relations of wear and repair in the nervous system. Explanations based on this general principle assume many different forms; our ignorance of

the exact nature of the complex chemical processes involved in assimilation and dissimilation of tissue, and of their connexion with functional activity and repose, leaves much room for speculation. The simplest form of statement is that when wear outruns repair the experience is displeasing, and that when repair outruns wear the experience is pleasing. On this view it is difficult to account for the fact that pleasures may be exhausting, and that when they are long-continued, they diminish, and pass into displeasure.

Mr. H. R. Marshall has propounded a theory which lays great stress on the building up of tissue during periods of functional repose. Pleasure, according to him, depends upon the building up of a surplus of stored energy acquired during the inaction of the organ. Where this surplus does not exist or has been consumed, the corresponding experience will be virtually neutral, so long as repair keeps pace with wear in the course of functional activity. If wear outruns repair, the corresponding experience is unpleasant. There is much to be said in favour of this view, and Mr. Marshall has said it with great clearness and force. Fatigue is in general a source of disagreeable, and freshness of agreeable, experience. Of course, the fatigue or the freshness must be that of the special tissues engaged in the functional activity. "After the quiet of the night-hours the bird-song, as we awake, is more than usually pleasurable; the rested eye sees beauty in all colours. The rubbing, at our morning bath, of the skin, which has not during the night felt the normal friction of our clothing; the flavour of some special food to which we have been accustomed, but which has not lately been tasted,—all are pleasurable."* A pleasant sensation,

* *Pain, Pleasure, and Aesthetics*, p. 200.

when too long continued, will become unpleasant, because the stored surplus is used up. What is a surplus relatively to one intensity of stimulation, will not be a surplus relatively to a higher intensity; hence by gradually increasing the intensity of a stimulus, we pass from pleasant to unpleasant phases of an experience. But along with these advantages the theory presents grave difficulties, if we attempt to base on it the whole explanation of the feeling-tone of sensation; and in my opinion it presents insuperable difficulties if we attempt to cover by its means all the pleasures and pains of perceptual and ideational activity. At present we are only concerned with sensation.

One obvious objection arises from the dependence of feeling-tone on quality as well as quantity of sensation. Why should some sensations be unpleasant at a very low intensity, and others be pleasing even at a very high intensity? Why should a comparatively small degree of bitterness or acidity be disagreeable, while a comparatively high degree of sweetness is agreeable? Mr. Marshall replies that there is a great variation in storage capacity, in the case of different sensation-processes. This explanation is probable enough in some cases. Where a function recurs with great frequency and regularity, and without much variation of intensity, as respiration does, we should not expect any large storage of energy. On the other hand, where stimuli occur irregularly, and with great variations of intensity, the organism can only provide against them by storing up a surplus in advance. But there are a large number of instances in which no such explanation appears applicable. Why should the same person dislike the smallest trace of vanilla, and keenly enjoy cloves or cinnamon? Why should the same person enjoy beef and

hate mutton? To account for such differences by variation in storage capacity seems forced.

A more important difficulty is connected with the conception of a surplus. How are we to fix what is, and what is not, surplus energy? Mr. Marshall says that there is a pleasure-giving surplus "whenever the energy involved in the reaction to a stimulus is greater than the energy which the stimulus habitually calls forth," and that pain is experienced "whenever the physical action which determines the content is so related to the supply of nutriment to its organ that the energy involved in the reaction to the stimulus is less in amount than the energy which the stimulus habitually calls forth."* There is ambiguity in this statement. The effect produced by a stimulus varies with its intensity; when Mr. Marshall speaks of "the stimulus," does he mean the same kind of stimulus in the same degree of intensity, or the same kind of stimulus in varying degrees of intensity? If he means to include varying degrees of intensity, his case obviously breaks down altogether; for when a stimulus is unusually intense, it is often unpleasant, although the effect which it produces is greater, and not less, than that which we are accustomed to. On the other hand, if he means the same stimulus in the same degree of intensity, only a comparatively small group of facts is available for verifying his hypothesis. The instances in which the same kind and intensity of stimulus yields alternately pleasure and pain to the same person are relatively infrequent. The best example, perhaps, is the gradual decrease of pleasure when a pleasing stimulus is prolonged. Here not merely the feeling-tone, but the experience itself, appears to become fainter; but it is by no means so clear that it continues to remain fainter

* *Op. cit.*, pp. 204-205

when it becomes positively disagreeable. Unpleasant experiences may be continued for a very long time indeed before they show any appreciable diminution of unpleasantness; and while they continue, it cannot be said that the effect of the stimulus is smaller than its habitual effect. When abatement of pain begins, the effect of the stimulus is smaller, the total experience becoming fainter. On Mr. Marshall's view we should expect, as an accompaniment of the diminishing effect of the stimulus, an increase and not an abatement of painfulness. This leads up to another objection; the intensity of unpleasantness appears to be in general proportioned to the intensity of the unpleasant experience. If Mr. Marshall were right in affirming that unpleasant stimulation produces a smaller effect than pleasant stimulation, we should expect unpleasantness of all kinds to be very much fainter than we actually find it to be.

We have discussed Mr. Marshall's views because they form a very favourable example of the theory which traces pleasure-pain to wear and repair of nervous tissue. In general, we may conclude that a large part of the explanation, at least for sense pleasure and pain, may be found on these lines. But no theory framed on these lines has been so formulated as to cover the whole ground successfully even for sensation, and they are all beset by special difficulties. After all, it is not, *à priori*, likely that merely quantitative conditions will be found adequate to account for the facts. Considering the great complexity of the chemical processes in organic tissues in interaction with the blood-supply, there may be all kinds of qualitative as well as quantitative variations. For instance, the accumulation of waste-products in the blood may be a very important factor. It is possible that what takes

place in repose and restores the freshness of organs is rather the removal of these waste products than the actual building up of tissues. There are considerations which tend to show that the building up of tissue takes place mainly during functional activity rather than during functional repose. We know that tissues suffer atrophy or degeneration if they are long disused. We merely refer to this point in order to show how speculative and insecure, in the present state of our knowledge, hypotheses of this kind are.

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